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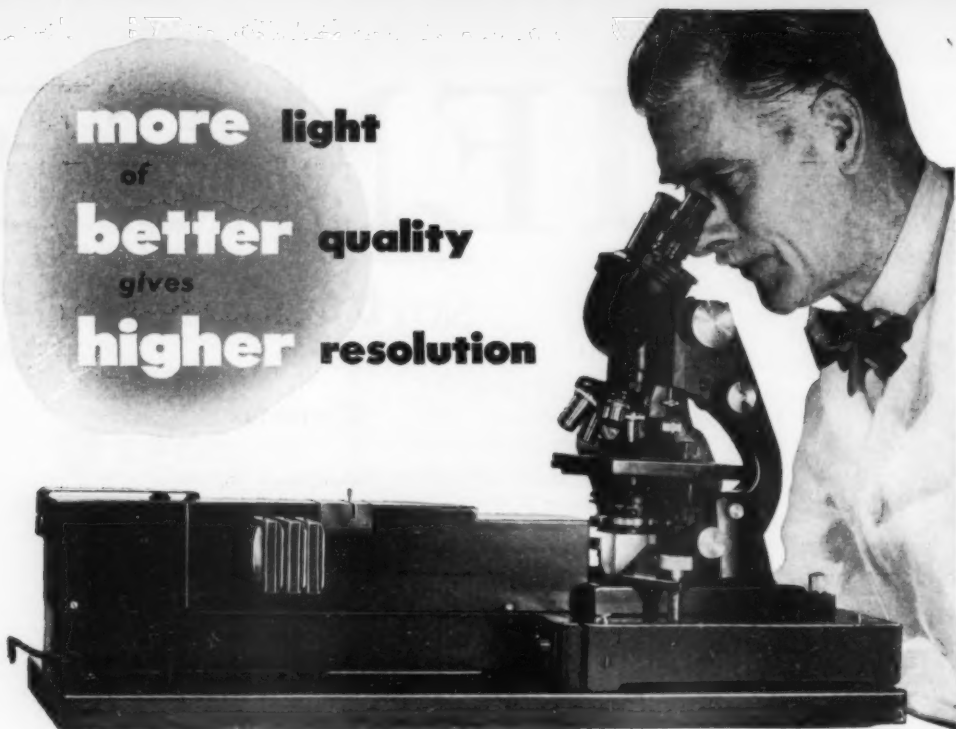
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Contents

| | |
|--|-----|
| Space, Field, and Ether in Contemporary Physics: <i>Alexander W. Stern</i> | 493 |
| Ralph Stayner Lillie: 1875-1952: <i>R. W. Gerard</i> | 496 |
| News and Notes | |
| The Physiology of Mammalian Germ Cells: <i>S. A. Asdell</i> | 498 |
| Technical Papers | |
| Evaporation of Some Plant Growth Regulators and its Possible Effect on their Activity: <i>W. Powell Anderson, Paul J. Linder,</i> <i>and John W. Mitchell</i> | 502 |
| The Antithyroid Activity of some Compounds that Inhibit Peroxidase: <i>I. N. Rosenberg</i> | 503 |
| Ascorbic Acid and Physiological Breakdown in the Fruits of the Pineapple (<i>Ananas comosus</i> L. Merr.): <i>Erston V. Miller</i> <i>and Alan S. Heilman</i> | 505 |
| Experimental Production of Hyperkeratosis ("X Disease") of Cattle with a Chlorinated Naphthalene: <i>Dennis Sikes</i> <i>and Mary E. Bridges</i> | 506 |
| Effect of Renin on Diuresis in Rats: <i>H. Croxatto,</i> <i>L. Barnafi, and J. Passi</i> | 507 |
| Mapping Functions in Tetrad and Recombinant Analysis: <i>S. Spiegelman</i> | 510 |
| Comments and Communications | |
| <i>David M. Hopkins, Robert E. Machol, D. B. O. Savile,</i> <i>and Demetri Shimkin</i> | 512 |
| Scientific Book Register | 514 |
| Petroleum Chemistry | 3 |
| Publications Received | 16 |
| Meetings & Conferences | 18 |

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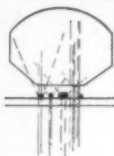
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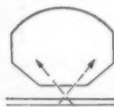
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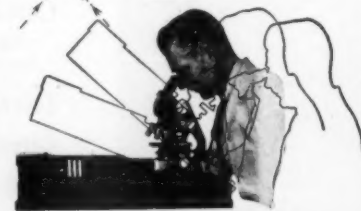
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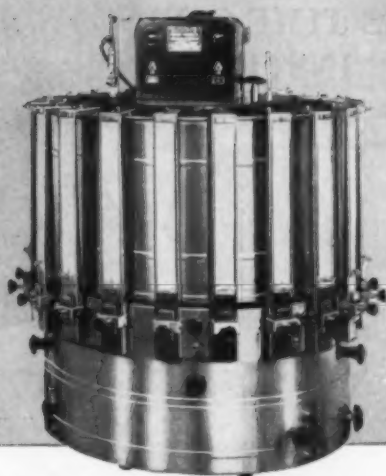
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Petroleum Chemistry

THE Gordon Research Conference on Petroleum last summer drew as many people from chemical as from petroleum companies. L. H. Flett was chairman of the conference on synthetic detergents, most of which are now coming from petroleum. W. K. Griesinger showed, by using radioactive sulfur in alkylaryl sulfonates, that complete removal of this type of synthetic detergent from hair is more difficult than anticipated. The first measurements with the hydrophil balance on these sulfonates, described by A. H. Batchelder, were carried on a substrate of 95 per cent sodium nitrate, and the effect of the hydrocarbon chain type was analogous to the carboxylic soaps. N. B. Tucker, reporting on sodium-sulfated detergents derived from alcohols, indicated that the C_{15} chain gave optimum properties.

In the conference on synthesis with higher olefins, organized by C. L. Brown, E. Arundale reported making a rich variety of metadioxanes, glycols, and unsaturated alcohols, using the Prinz reaction of formaldehyde with C_3-C_8 olefins. The metadioxanes and 1,3 glycols are formed in the presence of dilute acid catalysts, whereas unsaturated alcohols are produced when tertiary olefins are condensed with anhydrous formaldehyde in the presence of certain metallic halides or in the absence of catalysts at elevated temperatures. High yield of ketones can be obtained by reacting the higher aldehydes and olefins in the presence of peroxides.

C. M. Fontana reported on the synthesis of higher molecular weight polymers from 1-olefins using promoted $AlBr_3$ catalyst; a carbonium ion mechanism accounts for the product molecular weight distribution. J. N. Wilson showed that butene reacting with C_2 over Ni, even at -78° , yielded $C_4H_8D_2$ and all the possible deuterated species of butane.

W. A. Zisman was chairman of the session on lubricants. R. C. Morris reported on the lubricant properties of organophosphorus compounds, which have -65° viscosities, much lower than predicted. 1,5-Penta-

nediol-bis-dibutylphosphate, with a VI of 150 and a viscosity of 3.43 cs at $210^\circ F$, is a promising synthetic lubricant. The "surprising" reaction whereby several mols more than the neutralization equivalent of barium hydroxide with sulfonic acids make many motor oils alkaline was discussed by T. W. Mastin. A micelle of barium sulfonates enclosing the excess base was postulated as the mechanism.

G. W. Kennerly showed how the thiophosphoric acid derivatives and phenothiazine used for inhibiting motor oils cause the destruction of peroxides in an action more truly catalytic than that of the oxygen-accepting type commonly used as antioxidants, in that they survived. W. J. Toussaint said that mechanism of the formation of polyether synthetic lubricants is ionic. Temperature-viscosity properties are best when the molecule is doubly terminated with an alkyl and is made from propylene and ethylene oxides together. L. L. Withrow led a session on detonation and auto-ignition in internal-combustion engines. The adverse effects of combustion zone deposits, fuel additives, and blending hydrocarbons on tube oxidation reactions of the preflame type were brought out by P. L. Cramer. From engine studies Walter Cornelius developed the two-stage nature of preflame reactions, and E. M. Rifkin demonstrated the two-stage reaction by running an engine on the exhaust from a motored engine; B. M. Sturgis observed substantial and unexpected amounts of hydrogen peroxide in the products of preflame reactions in a combustion zone.

D. R. Stevens presided over the session on antioxidants. J. A. Chenicek discussed the relation of structure of antioxidants to their effectiveness in gasoline and the differences found between various phenols. E. C. Knowles pointed out that preflame reactions in engines lead to reactive intermediates, causing sludge that the motor oil must disperse. C. M. Murphy and W. A. Zisman showed that the diesters of pinic acid are as valuable for synthetic lubricants as the sebacates.

E. C. HUGHES

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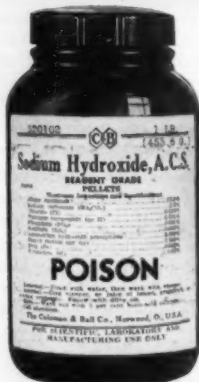


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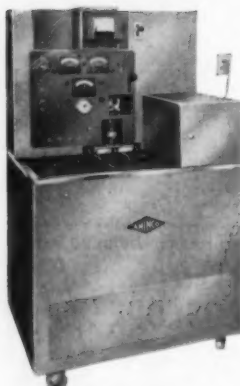
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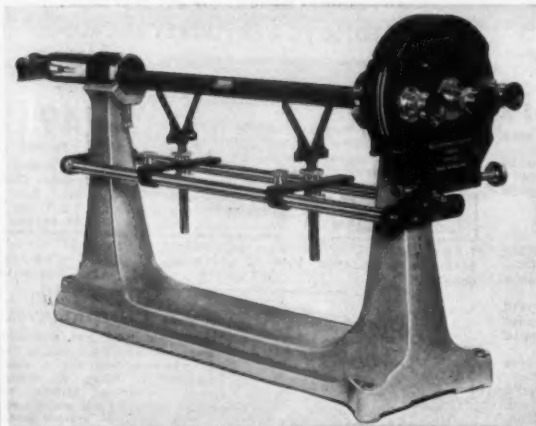


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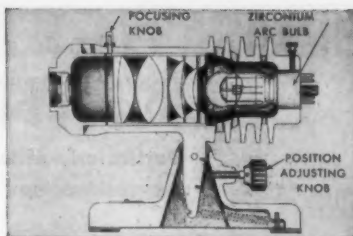
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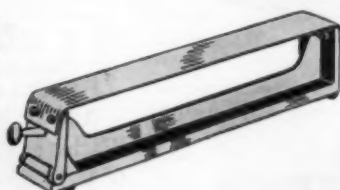


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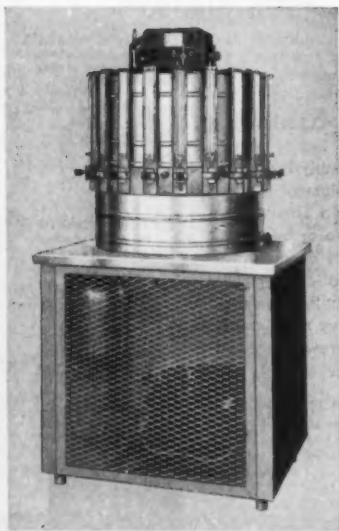
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Space, Field, and Ether in Contemporary Physics

Alexander W. Stern
Flushing, Long Island, New York

THE RELATIONSHIP BETWEEN MATTER AND SPACE may be expressed by saying that matter occupies space and shapes its geometry. This statement, however obvious and comprehensive it may seem, does not embrace all the properties of space. It holds only for matter in bulk occupying large volumes of space—in short, on the macroscopic plane.

One of the most important results of quantum field theory, the implications of which have only recently been realized, is that empty space exhibits dynamic properties in the presence of matter and field. This interaction between matter, field, and empty space is of a radically different nature from the static, geometrized effect that matter has on space in accordance with relativity theory.

The Compton wavelength of the electron, $\frac{h}{mc}$, one of the elementary lengths of physics, signifies the emergence of the dynamic properties of empty space—or the vacuum, as it is called—as well as its creation properties, which exhibit empty space more in a quasi-passive character. Vacuous space is something much more complex than can be described by simple mathematics. Its properties arise because the universe contains matter. Were there no electromagnetic fields or electrons, for instance, there would be no electromagnetic field, electric charge, or current fluctuations in the vacuum.

With reference to its creation properties, empty space behaves as if it were a sea of negative energy electrons—of latent electrons. This connotation is well known and needs no detailed discussion here (1). It is evoked to explain the well-known phenomenon of electron-pair creation.

The dynamic properties of the empty, or vacuous, regions of space in this region of magnitude arise out of the zero-point oscillations of the electromagnetic field and the zero-point fluctuations of electric charge and current (1). Because of the zero-point oscillations of the electromagnetic field, the average value of the electric and magnetic field strengths, when measured over a space-time extension of the order of the electron Compton wavelength, will not be zero, as one would expect for empty space, but will fluctuate upon repeated measurements. These fluctuations will become greater as the space-time region becomes smaller. Because of the possibility of the creation of electron

pairs by these electromagnetic field oscillations (the electromagnetic field here is, of course, a quantized system of virtual photons), there will ensue electric charge and current fluctuations that will also become of greater value as the space-time region of measurement becomes smaller.

These vacuum-fluctuation phenomena, unobservable in principle as well as in practice, were not taken seriously until their physical consequences received experimental confirmation in the now famous Lamb shift. There is also an interaction of a charge, electron or proton (the principal contribution is from the electron), with the latent electrons of empty space, causing a displacement of these electrons and giving rise to what is called the polarization of the vacuum. As to the reality of this phenomenon, there may still remain a few dissenters. However, this effect will cause another hydrogen S level displacement, about 1/40 of the Lamb shift, and it may be within the range of present-day experimental technique. Recent calculations involving terms of higher order in the interactions would seem to indicate the existence of such an effect (2).

The dynamical properties of the vacuous regions of space should be viewed not as belonging to empty space, but as arising out of its interaction with matter and radiation fields. Without interaction this dynamism of empty space is but a formal abstraction lacking physical reality. It is interaction that bestows upon it its substance-like properties. The concept of isolated particle and isolated field existing as absolutes without interaction with other matter and fields is also but a formal abstraction lacking physical reality (as will be discussed later). This fundamental and unique role of interaction in physical phenomena, however, is nowhere else so clearly brought out as in these vacuum interactions.

It is probably not correct to consider the interaction between empty space and matter even formally as a perturbation, because the various types of interaction between the two give rise to infinite energies. Dyson (3) has shown that these infinities are of a basic nature and cannot be eliminated by any formal mathematical procedures, such as the renormalization method. A more serious objection against perturbation theory, although of a different nature, was recently brought forward by Van Hove (4). These infinities are not an indication that quantum electromag-

netic theory is wrong (5), but rather that the theory is in a sense an open one. That is to say, as we consider smaller and smaller regions of space, we shall find that electromagnetic phenomena do not exist by themselves but are connected with the occurrences of other types of phenomena. This will involve other matter and radiation fields and the creation of different particles other than electrons and photons. The elementary particles are not absolute; they are all related, and their number may well be legion. It is this large number of elementary particles and their relatedness that introduce a new and undreamt-of complexity into physics.

It is not unlikely that there are several elementary lengths in physics, each one signifying the emergence of some new phenomenon or the limit of the unambiguous application of some particular physical concepts and laws.

For distances of the order of the Compton wavelength of the π meson, $\frac{h}{\mu c}$, the region of nuclear interaction, the concept of a static potential does not seem to have an unlimited validity. All attempts so far to account for the saturation property of nuclear forces by a static potential have not been successful, and it appears possible that many-body forces may have to be evoked (6). Moreover, the experimental results on proton-proton scattering from 120 to 345 mev have defied theoretical interpretation in terms of conventional interactions and models.

For distances of the order of, and less than, the Compton wavelength of the proton, $\frac{h}{Mc}$, it is probable that the very concept of measurement loses some of its concise and clear-cut classical meaning. In this region the elementary particles must be recognized as complex interacting systems consisting of the "bare" particle and the virtual quanta of their associated fields, which they are continuously emitting and absorbing (5). The elementary particles themselves all have about the same size, about 10^{-13} cm, which is larger than the region in which such measurement takes place. Consequently, any position measurement, say, of a particle in this region will involve an interaction so vigorous as to cause the structure of the elementary particle that is used for the measurement to come into play. Because the various elementary particles have different structures, a position measurement will not have the unambiguity necessary for the concept to have a concise meaning. Instead, the result of the measurement will depend on the type of particle employed for the measurement. Each type of particle—electron, proton, or photon—will yield a different set of measurements and, consequently, there will be no objective probability distribution essential for a measurement.

It is of interest to note that the elementary particles, which are more than a billion times smaller than living cells, have this in common with them. They are both complex, interacting systems that must be

considered as wholes. No observation is possible on these elusive fundamental units, living and nonliving, that would reveal the nature of the interaction between their component systems. The difference between the two is that we have succeeded in forming some theoretical conceptions of the interacting systems that constitute the fundamental particle, and we can verify them by their experimental consequences. No such theoretical knowledge of the "self-interactions" of the living cell (those interactions that produce the unity and organization of the cell) is available. It may well be that fundamental advances in this field will not be forthcoming until we gain a better theoretical knowledge that would suggest the decisive experiments necessary for an understanding of the living cell, and that would go hand-in-hand with experiment and observation.

Pertaining to the importance and function of theory, where direct observation is not possible, it is the author's opinion that one of the most important achievements resulting from the recent relativistic covariant formulation of the quantum electrodynamics is the explanation of the Lamb shift and the anomalous magnetic moment of the electron as the *measurable consequences of the unobservable field and charge fluctuations of empty space interacting with the electron. The real in physics encompasses more than the directly observable and measurable.* Interaction and charge are fundamental in nature, and there are interactions besides those that are directly involved in measurement and observation. The self-interactions are an example, and they may have important physical consequences.

It has been stated that the elementary particle is an open, even complex, system in constant interaction with the vacuum fluctuations of its associated fields. For example, the structure of the electron includes its virtual photon field, and the structure of the nucleon its virtual meson cloud. But elementary physical systems themselves may be related to other elementary physical systems, as suggested above. The divergence of the higher order terms in the electron self-energy interaction may indicate the necessity of simultaneously taking into consideration the existence of other kinds of particles. Thus there may be a theoretical indication of the relatedness of the elementary particles. There is also experimental evidence suggesting this. Transitions involving decay and collision processes between V -particles, nucleons, and π -mesons; π -mesons, μ -mesons, electrons, and neutrinos; neutral π -mesons, γ -rays, and electrons; K -mesons, μ -mesons, electrons; protons, electrons, and photons, show, as was pointed out by Heisenberg, that one elementary particle may be related to another by a series of real and/or intermediate steps.

All this suggests that in the atomic and nuclear domain the assumption that elementary particles are closed systems may not have an unlimited validity. The great revolutionary finding that contemporary physical theory points to is that the simplicity which has so uniquely characterized physics since its birth

needs essential qualifications. The simplicity that will remain as characteristic of physics will be of an aesthetic, symbolic nature, expressed only in the formalism of its mathematics.

It is in the extremely high-energy region, where interaction can take place within a radius of the nucleonic Compton wavelength $\frac{h}{Mc}$, that one may meet with this new complex aspect of physics. Here it may no longer be valid to assume that clear, unambiguous distinctions can be made between and among the various component systems in interaction. It may not be possible to isolate the interacting systems and to treat them as being separate but for their mutual perturbations.

It was Dirac's idea that some of these difficulties, at least in certain aspects, should be recognized on the classical level—for instance, that interaction should not be considered simply as a perturbation. Dirac's recent work (7-9) recognizes the coexistence of particle, field, and interaction, all on an equal dynamical footing. The electrons, in his new theory, are not considered apart from their interaction with the electromagnetic field, because the theory considers only electron beams. The existence of the elementary charge e is presumably a quantum phenomenon. Therefore, there is no e to set equal to zero. The first approximation of the usual classical theory sets $e = 0$ and then introduces the electromagnetic interaction as a perturbation. In Dirac's theory the motion of electron streams only is considered, and a velocity distribution given by his potentials is associated with them.

I have stressed the importance of the dynamic or interacting properties of empty space with respect to matter and radiation fields. One may ask, in the spirit of classical physics, whether it is not possible to analyze and isolate these interacting properties with neither matter nor field present. Completely empty space with neither matter nor field present is an idealized condition and can never be actually realized. However, the perfect vacuum—empty space—in the light of the implications of contemporary quantum field theory, is not exactly equivalent to nothing. Because of its dynamic or interacting properties, empty space may be equated to mere activity. For instance, there is the interaction between the electromagnetic field oscillations with the latent electron pairs of the vacuum. But this character of empty space, as discussed previously, can become manifest only by measurements involving wavelengths of the order of

$\frac{h}{mc}$. Nevertheless, it may be instructive, or at least

suggestive, to inquire whether the dynamic character of vacuum space can be carried over in some guise to classical theory and clothed with a classical concept. In the opinion of the author, something of this nature is what seems to have been accomplished by Dirac in his attempts to formulate an adequate classical theory with one eye on the quantum theory and in his ensuing rediscovery of the ether (10, 11).

Because it is interaction with which we are dealing, one may apply the knowledge gained by quantum mechanics to the interacting properties of the vacuum, or empty space. Quantum mechanics is made possible by the existence of the natural constant of interaction h , just as relativity exists because of the natural constant c . One could set up a wave function that would describe a state which could not be physically identified, but which represents the vacuum. A wave function of this type is one that would yield all motion or velocity values and directions as equally probable, which is the symmetry property demanded by relativity for the existence of an ether. This ether of Dirac, which is fashioned out of the knowledge gained from quantum mechanics, is not amenable to mechanical description. It may be looked upon as a property of space-time. For this reason, it bears little resemblance to the old-fashioned ether. It may be defined as *hypostatized interaction*, or interaction considered as a thing in itself. It may occur to many that this abstraction is too much, even for contemporary physics. On the other hand, in the light of quantum electrodynamics, an isolated particle or a field is not a closed system, as in the classical definition, but it is constantly interacting with the vacuum fluctuations of its associated fields. The classical concepts of particle and field are as much an abstraction as the concept of isolated interaction. That the concept of interaction has not been treated separately as "action," in the manner of particle and field in the Newtonian and Maxwellian physics, may be a matter of psychology. Isolated particle, field, or action may be legitimately viewed only as theoretical idealizations. In the view presented here, one of the functions of the ether is to give interaction a fundamental role in classical theory that would place it on an equal footing with particle and field.

It is of interest to note that the properties of the vacuum in Dirac's classical theory are somewhat suggestive of its properties in the quantum domain. His theory involves a velocity field that exists even in empty space. The velocity field, which is a continuum of velocity values, because of its omnipresence will not permit the field quantities to be zero, even—to use Dirac's connotation—in a "perfect vacuum." Consequently, it is not surprising that one of the fundamental equations of Dirac's theory giving his potentials in terms of velocity can be fulfilled for a vacuum as well. This equation yields a definite velocity throughout space-time, which may be interpreted as the velocity of an ether. Dirac (12) interprets the ether velocity in the vacuum regions of space as the velocity of a small charge, were it introduced, although the introduction of a charge in the vacuum would violate the conservation of electricity. However, in the equations of his theory, a small charge may be introduced in the guise of initial conditions. And so, even in the classical domain, empty space, because of its ether and velocity properties, and its function as a site for charge creation, exhibits a dynamism somewhat suggestive of its role in quantum theory. Would

a final classical theory yielding an adequate quantum theory be as different, conceptually, from present classical electron theories as Dirac's is?

In any event, one of the significant results of recent investigation in quantum field theory, and even in classical field theory, as just indicated, is the recognition of the complexity behind the ultimately simple. And so a new chapter in physics opens, with overtones suggesting that the simplicity of this fundamental intellectual discipline may reside principally in the aesthetic character of its mathematical elegance.

References

1. WEISSKOPF, V. *Rev. Modern Phys.*, **21**, 305 (1949).
2. KARPLUS, R., et al. *Phys. Rev.*, **84**, 597 (1951); BARANGER, M. *Ibid.*, 866.
3. DYSON, F. J. *Ibid.*, **85**, 631 (1952).
4. VAN HOVE, L. *Physica*, **18**, 145 (1952).
5. STERN, A. W. *Physics Today*, **2**, 21 (1949).
6. SCHIFF, L. I. *Phys. Rev.*, **84**, 1 (1951).
7. DIRAC, P. A. M. *Nuovo cimento*, **7**, 925 (1950).
8. ———. *Proc. Roy. Soc. (London)*, **A**, **209**, 291 (1951).
9. ———. *Ibid.*, **A**, **212**, 330 (1952).
10. ———. *Nature*, **168**, 906 (1951).
11. INFELD, L. *Ibid.*, **169**, 702 (1952); DIRAC, P. A. M. *Ibid.*
12. DIRAC, P. A. M. *Ibid.*, 146.

Ralph Stayner Lillie: 1875-1952

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THE SCIENTIFIC LIFE of Ralph Stayner Lillie neatly spanned the first half of this century, his first paper appearing in 1901 and his last, just fifty years (and some 125 publications) later. In this period he and a handful of other leaders effectively created the subdiscipline of general physiology. For Lillie had an integrating or generalizing mind; he had little concern for the particular—although his experiments revealed many important facts—and he probed unceasingly for the deeper import and broader impact of the phenomena that engaged his attention. Not the effect of some ion on some function, but the nature of ion action on the colloids and membranes of protoplasm interested him; not fertilization or contraction or conduction, but the whole problem of irritability and response. Few acres of the field of general physiology were not plowed by his sharp understanding and seeded by his generalizing insight.

A complete bibliography of Lillie's papers was prepared for me by Deborah Harlow, librarian of the Marine Biological Laboratory at Woods Hole, and from this alone emerge many interesting lights on his work and his period. In his first decade of publication (1901-10) six papers appeared in such journals as *Biological Bulletin* and *Journal of Experimental Zoology*, and 14 appeared in the *American Journal of Physiology*—the latter including articles on *Arenicola* larvae, the swimming plate of *Ctenophora*, and the eggs of *Asterias* and *Arbacia*. Two decades later (1921-30) only four of 27 papers reached the *American Journal of Physiology* (and these by 1923), the others being distributed in such new publications as *Journal of General Physiology* and *Journal of Cellular and Comparative Physiology*, the second a journal he helped found and edit. The dozen papers of Lillie's last decade were mostly in philosophical journals—he published in 24 different periodicals over his profes-

sional life span—but this represented a shift in emphasis, whereas the earlier change reflected the altered interest of physiology and the growth of its cellular and general offspring.

Only nine of Lillie's papers had a joint author, and five of them were students. In part this reflected the times, for multiple authorship was the exception earlier in the century; in part it may have represented an inclination to have students publish separately; but largely it must have resulted from his personal qualities of mind and manner. Omnivorous in his reading, eager always to discuss (despite some hearing difficulty) or to correspond about an interesting problem, generous in instructing students, at which he was most successful outside the classroom, Lillie was still a solitary worker. His thoughts and labors were his own, and his main influence on others, including the oncoming generation, was exerted by way of the written word, despite the long, busy, and happy summers he spent throughout his adult life in the teeming scientific community of Woods Hole.

The first paper Lillie published established the basic themes of his scientific work. "On the Differences of the Effects of Various Salt-Solutions on Ciliary and on Muscular Movements in *Arenicola* Larvae" touched upon ion action and antagonism, colloids and membranes, irritability and response. The dramatic actions of the common ions of protoplasm never exhausted his interest, and one of his last experimental reports dealt with "The Influence of Neutral Salts on the Photodynamic Stimulation of Muscle." He related ions to the dispersion state of colloidal particles and so to osmotic pressure and membrane permeability, to fertilization and mitosis, to stimulation and anesthesia, to contraction and conduction, to the action of drugs and radiations.

Lillie was perhaps most widely known for his contributions to neurophysiology, especially his provoca-

tive passive iron wire model of nerve fiber conduction (one of many models he studied in relation to other phenomena—e. g., growth). Yet his first paper dealing with nerve (as also his first explicitly philosophical article) did not appear until 1914, "The Conditions Determining the Rate of Conduction in Irritable Tissues and Especially in Nerve;" and his classic on the iron wire, "The Recovery of Transmissivity in Passive Iron Wires as a Model of Recovery Processes in Irritable Living Systems," was not published until 1920. This model, with its eddy currents and membrane of functionally variable resistance, mimicked surprisingly well the physical and physiological attributes of a nerve fiber, predicting saltatory conduction, establishing a relation between surface area and threshold and between resistance and conduction velocity, and giving powerful support to the membrane theory of propagation. This approach was summarized in 1922 in *Physiological Reviews*, "Transmission of Physiological Influence in Protoplasmic Systems, Especially Nerve;" in a lecture on "The Physical Nature of Nervous Action" published in 1929 in the *American Journal of Psychiatry*; and in his definitive volume on *Protoplasmic Action and Nervous Action*, published (2nd ed.) in 1932 by the University of Chicago Press.

No scientist with such a holistic view of his subject could fail to develop philosophical interests, and in the biological domain these would necessarily touch on problems of directive influences on the formation, organization, and behavior of living organisms. Lillie became steadily more engrossed with these problems, and after 1941 all his publications were in the field of philosophy. Unlike many scientists who make casual forays into a foreign territory, he established a thorough competence in this field, published largely in the professional journals of the discipline, and was accepted by the philosophers as one of themselves.

A series of papers in the *Journal of Philosophy*, and later in the *Philosophy of Science*, dealt with such subjects as "The Problem of Vital Organization" (1934), "Biological Causation" (1940), "The Problem of Synthesis in Biology" (1942), and "Vital Organization and the Psychic Factor" (1944). Lillie was regarded by many as turning to vitalism in his later writings, and surely he was far from the hard determinism of most of his colleagues; but he eschewed mysticism in his thinking and sought insistently for factors that contribute to stability, on the one hand, and to innovation, on the other. The latter he termed "psychic," and thereby he may have invited some misunderstanding. A summary of his views was published in 1945 by the University of Chicago Press as *General Biology and Philosophy of Organisms*.

Ralph Lillie was born in Toronto on August 8, 1875, and received his bachelor's degree from the University of Toronto in 1896—and an honorary D.Sc. in 1936. Although he came to the United States for his gradu-

ate training (Ph.D. in zoology from the University of Chicago in 1901) and subsequent career, he remained a Canadian citizen. He taught at Nebraska, Harvard, Johns Hopkins, and Pennsylvania before settling at Clark University for seven years as chairman of the Department of Biology. There followed a four-year period at the Nela Research Laboratory before he returned to the University of Chicago in 1924 (where his elder brother, Frank, was established in the Department of Zoology) as professor of physiology for a quarter-century, including a decade as professor emeritus.

Lillie's life centered, physically, about two loci, Chicago and Woods Hole. In early spring a restlessness would seize him, and it became irresistible as the starfish eggs came into season. His year-long course in general physiology was finally telescoped into fall and winter quarters so that the vernal flight was not delayed; and the autumnal return was postponed to the limits of conscience. At Woods Hole, manipulating echinoderm eggs in finger bowls in his third-floor laboratory, or playing a piano duet with Leonor Michaelis, or entertaining with his wife, Helen, his enduring close companion, in his hospitable frame house, or carrying his green bag of papers to and fro, Ralph Lillie seemed most fully himself. It was fitting to hold there a memorial service for him.

The external marks of success were upon Lillie—a trusteeship in the Marine Biological Laboratory, election to the American Philosophical Society, memberships, lectureships, editorships. But his real success was in his character, his thoughts, his appreciation, in the affection given him by his intimates, and the respect given him by his peers. I would generalize what I wrote of him at the University of Chicago:

Ralph Stayner Lillie left us on March 19, 1952, with the same quietness in which he lived so many years among us. Gentle, reticent, deeply thoughtful, he was less widely known on the campus than a number of his colleagues. But those who did come to know him—and these included leaders in science and philosophy and statesmanship throughout the world—prized him as a really creative thinker. In him were blended the experimenter and the artist, and he possessed in generous measure that vein of philosophy seen in all great scientists.

Lillie's analysis of the nature of organism, of evolutionary process, of nervous action, was profound and productive. In his own articles and books and in the publications of his many students and followers are insights and investigations that have enriched all of biology. His penetrative discourse opened vistas of thought to those of us who enjoyed hours with him beyond the classroom level.

If ever the true scholar—wise, humble, kindly, broadly informed and interested, dedicated to the human values of living—graced our quadrangles, Ralph Lillie was such a one.

News and Notes

The Physiology of Mammalian Germ Cells

IN A Ciba conference held in London June 17-20 upon the topic "The Physiology of Mammalian Germ Cells," 24 papers were given by workers from six countries under the rotating chairmanship of John Hammond and S. J. Folley.

Papers and discussions came back again and again to the need for a good criterion for fertilization of the egg, and for cell division as opposed to fragmentation. Venge took the view that real fertilization consists of the fusion of male and female pronuclei, but, from a practical standpoint, this is not easily demonstrated. Hartman and others considered that an egg was fertilized if spermatozoa could be found within the zona pellucida. The problem is important, since much work is now being directed toward finding out why so many eggs fail, especially in cattle, during the first few cell divisions. Egg transplantation techniques usually involve exposure of the oviduct, and the lowered local temperature that results may induce parthenogenesis; this is another reason why good criteria are urgently needed.

Eggs shed by the use of gonadotrophic hormones while an active corpus luteum is present are low in fertilizability, and the reason is not clear, according to Casida. It may be linked to the ease with which the uterus becomes infected at this stage of the cycle. In his view it is not due to failure of spermatozoa to reach the eggs. Asdell suggested that more information is needed upon the condition of the egg in induced ovulations, whether or not it had shed the first polar body. He pointed out that rodent eggs are much more readily fertilized than the eggs of domestic animals. Adams reported that, in egg transplantation work, the age of the donor rabbit is immaterial for effective fertilization and transplantation, but that immaturity of the recipient is harmful. Chang reported that eggs had been successfully implanted into doe rabbits after they had been flown across the Atlantic. Willett spoke on successful transplants of bovine eggs.

Low-temperature storage of spermatozoa is now practical, but species differ in the best methods of applying the technique. Parkes and Polge have found that fowl and human spermatozoa withstand deep-freezing well, but the rabbit sperms are very sensitive, whereas bull sperms are intermediate. An important factor in obtaining success is the use of glycerol in the diluent, a factor that was discovered accidentally. Other saccharides do not have a protective effect. Mann expressed the view that the specific protective action of glycerol may be due to its influence upon the physical state of the mixture during cooling. Slow reduction in temperature is another important factor in using the technique.

Another lively discussion arose round the problem of ovum neogenesis from the germinal epithelium.

Audrey Smith has found that ova are destroyed when ovarian fragments are deep-frozen, but that they are soon regenerated when the fragments are implanted into recipient does, or are cultured. In Zuckerman's experience this may occur when the germinal epithelium is completely destroyed, and he urged that one cannot be certain of the facts unless complete counts are made in the experimental tissues.

Material progress was reported in the field of sperm metabolism. Mann has found species differences in inositol content of semen. In species with high inositol, fructose is low, and vice versa. Kok produced evidence to show that the salt/sugar ratio is important for sperm survival. Gassner has isolated various amino acids in the accessory fluids by chromatography. They decrease in amount after either castration or vasectomy and in each case they are restored by injecting testosterone propionate—a difficult result to explain. Lundquist has investigated the enzymes of human semen and has found a proteolytic enzyme allied to aminopeptidase that has the effect of increasing the amino acid content. The significance of the presence of amino acids in semen now arises. Lundquist also reported the presence of an enzyme that appears to be pepsin, but, since the optimum pH of pepsin is below 4, its use is problematical. It is absent from bovine semen. Mann has also been investigating the role of a hexokinase, concerned in fructolysis, in sperm metabolism. Lord Rothschild, in a paper upon the energetics of sperm movement, pointed out the importance of high-energy phosphate in fructolysis. He regards the energy produced anaerobically in this process as the important output for the spermatozoon and expressed the view that aerobic metabolism exists solely to "mop up" lactic acid. Mann doubted whether this is the sole function of aerobic metabolism, since the energy produced in this process is much greater than that produced by anaerobic fructolysis. McLeod, too, questioned Rothschild's hypothesis, pointing out that the energy output by spermatozoa is much greater than is needed for their motility. He believes they have other functions requiring energy. In human semen, he said, practically all metabolism is anaerobic. The discussion, in general, showed the danger of applying results obtained with one species to another.

Lord Rothschild also reported some interesting experiments on sperm movements, which have been investigated by stroboscopic methods. Sea urchin spermatozoa travel in loops, whereas bull spermatozoa travel in intermittent tracks, possibly because they turn over as they swim. He said that chemotaxis is found in the plant kingdom only, not in the animal kingdom, and that sperms find the eggs by other means.

This conference once more showed the superiority of small meetings in which adequate discussion can be carried on among workers interested in a fairly spe-

cialized field. The director of the Ciba Foundation, G. E. W. Wolstenholme, is to be congratulated upon the organization that produces such successful symposia. The proceedings are to be published soon.

S. A. ASDELL

Cornell University

Scientists in the News

Holger Arbman, of Lund University, is the leader of an expedition to the Bikaner Desert, west of Delhi, where the Bronze Age cities of that region will be studied. The expedition hopes to take back to Sweden a considerable number of ceramic objects for comparative study.

Alexander W. Bouchal, biochemist and graduate of Pennsylvania State, has joined the research staff of the Colgate-Palmolive-Peet Company, Jersey City.

Philip A. Boyer, associate medical director of Schenley Laboratories, Inc., has been appointed a member of the Committee on Resident Fellowships of the American College of Chest Physicians. Purpose of the committee is to establish fellowships in the U. S. for physicians from other countries.

J. H. U. Brown, assistant professor of physiology at the University of North Carolina School of Medicine, has accepted a position as associate professor of physiology at Emory University School of Medicine.

Edward Bernard Bunn, regent of the Georgetown University Dental School and the School for Nursing, has been appointed president of the university, succeeding **Hunter Guthrie**, who held the post from early 1949 until last July, when he went on leave. Father Bunn is the 36th president of the 163-year-old Jesuit university. He was president of Loyola College from 1938 to 1947. Since 1947 he has served as director general of studies for Jesuit colleges in the Maryland Province of the order.

Thomas H. Clark, Logan professor of paleontology, has been appointed chairman of the Department of Geology at McGill University, replacing **J. J. O'Neil**, who has retired.

Eric T. B. Gross, professor of electric power systems engineering at Illinois Institute of Technology, has been elected national vice president of Eta Kappa Nu, electrical engineering honor society. He will automatically become president next year.

Frederic Keffler has joined the University of Pittsburgh as assistant professor of physics. He was formerly at the University of California.

William T. Kirk has been appointed international director of International Social Service. In his new post he will direct the organization's worldwide social service program while continuing to head its American branch. International Social Service, founded in 1924,

maintains consultative status with the Economic and Social Council of the United Nations.

Roland E. Kremers, until recently connected with the Central Laboratories Division of General Foods, has been appointed research associate in organic chemistry at the Institute of Paper Chemistry. Dr. Kremers became associated with General Foods as research chemist, and at its Central Laboratories Division since 1939 he has been successively in charge of organic research, assistant manager, and manager of basic research.

Edward Mallinckrodt, Jr., chairman of the board of the Mallinckrodt Chemical Works, St. Louis, has won the 1952 Midwest Award of the American Chemical Society's St. Louis Section. The Midwest Award, consisting of an inscribed gold medallion, is conferred annually upon a scientist of the Middle West in recognition of "meritorious contributions to the advancement of pure or applied chemistry or chemical education."

The seventh annual James Greenwood Lecture in Neuro-Surgery will be given on Nov. 24 at the University of Texas Medical Branch, Galveston, by **Herbert Olivecrona**, professor of neurosurgery at the University of Stockholm. Professor Olivecrona will talk on "The Treatment of Arteriovenous Aneurisms of the Brain."

Samuel White Patterson has retired as professor of education at Hunter College. On the staff of the college since 1930, Dr. Patterson plans to devote his time to research.

Henri Polak has been appointed scientific attaché at the Netherlands Embassy, Washington, D. C., succeeding **John J. Verschuur**, who has held this position since Jan. 1.

Mark M. Ravitch, associate professor of surgery at the Johns Hopkins School of Medicine, has been made full-time surgeon and head of the Department of Surgery at Mount Sinai Hospital.

Elizabeth Healy Ross, specialist in psychiatric social work, has been named to the new position of deputy chief of the Children's Bureau. She will work under **Martha M. Eliot** directing the bureau's research into child life and administration of grants to states for improving children's health.

Heyworth N. Sanford has been appointed acting head of the Department of Pediatrics in the University of Illinois College of Medicine, filling the vacancy created when **Henry G. Poncher** resigned (*SCIENCE*, 115, 346 [1952]). Dr. Sanford has been a member of the university faculty since 1941, when he was appointed clinical associate professor of pediatrics. His association with Rush Medical College and Presbyterian Hospital dates back to 1928.

M. G. Van Campen, director of organic chemistry, the Wm. S. Merrell Company, Cincinnati, has been elected chairman of the Division of Medicinal Chemistry of the American Chemical Society.

Education

The Army Medical Service Graduate School will present a five-day course in "Medical Aspects of Nuclear Energy" Nov. 17-21 at Walter Reed Army Medical Center. Among the instructors will be E. DeCoursey, Wm. Stone, R. Hinners, and R. Gerstell.

Woodrow Krieger, president of Douglas Oil Company of California, is the sponsor of the Loma Linda School of Tropical and Preventive Medicine expedition to the Galápagos to collect data and fish specimens in a study of poisonous fishes, sharks, and other noxious marine animals. The expedition party of 14 will leave Los Angeles Nov. 25 aboard Mr. Krieger's yacht, *Observer*, which will serve as a floating base. The investigations are the continuation of a five-year project, under the leadership of Bruce Halstead, which has been supported by grants from the U. S. Public Health Service and the Office of Naval Research.

The Maryland Institute of Metals has been organized at The Johns Hopkins University to stimulate interest in applied and scholastic aspects of metallurgy. The institute is open to all interested persons in the Baltimore and Washington areas. At the first meeting, held Oct. 28, Neng-Kuan Chen, of the Hopkins faculty, discussed the use of the x-ray as a microscope. Rolfe Pottberg has been elected president; Robert Maddin, secretary; and Lee Weitzenkorn, adviser.

Massachusetts Institute of Technology has established a Division of Biochemistry in the Department of Biology, to begin operation on July 1, 1953. John M. Buchanan, professor of physiological chemistry at the University of Pennsylvania, has been appointed professor and head of the division.

Temple University is presenting a series of chemistry lectures which began on Nov. 5, with Jesse P. Greenstein as speaker. Other speakers will be W. Conard Fernelius (Jan. 15); George B. Kistiakowsky (Feb. 5), Charles D. Coryell (Mar. 5), and Herbert Brown (Apr. 9).

Union College will be the locale Nov. 12-13 of a conference of the New York Educational Television Institute, sponsored by the Association of Colleges and Universities of the State of New York. The Fund for Adult Education has financed the two-day workshop, and General Electric Company has supplied the technical equipment. Live demonstrations will present "The Living Blackboard," New York City School System program, and a typical program from Syracuse University.

The U. S. Weather Bureau has moved from the U. S. Courthouse in Chicago to the University of Chicago in order to make use of the university's Department of Meteorology, of which Horace R. Byers is chairman. Sverre Pettersen, Norwegian forecaster, is joining the faculty and will work closely with the bureau. His appointment was financed by the Air Force.

Grants and Fellowships

Ethyl Corporation has increased its grants for graduate work from 12 to 21. As in past years, the 1952-53 fellowships were awarded in fields related to the petroleum, chemical, and automotive industries.

The Lalor Foundation, through a grant to the Marine Biological Laboratory, Woods Hole, Mass., is offering a limited number of postdoctoral fellowships in biochemistry, biophysics, and physiology, designed primarily for young scientists who wish to work not less than two consecutive months during the summer in investigations at Woods Hole. The stipend is intended to cover laboratory fees, travel, and living expenses. For full information and application blanks (returnable Dec. 31), address the Woods Hole laboratory director.

The National Heart Institute, USPHS, is conducting a research training program in enzyme chemistry at the Institute for Enzyme Research, University of Wisconsin, under the direction of D. E. Green and H. A. Lardy. Stipends conform to those in effect for postdoctorate research fellows of the Public Health Service. Full information may be obtained from the institute.

In the Laboratories

Consolidated Engineering Corporation has added the following to its engineering and research staffs: Wilson S. Brubaker, of Westinghouse Electric Corporation, as senior research physicist; and Paul Broek, of Reeves Instrument Corporation, as engineering mathematician.

W. R. Grace & Co. has formed the Grace Chemical Company, a wholly owned subsidiary, for the production of petrochemicals. The company has purchased a 277-acre site near Memphis, Tenn., where ground has been broken for an \$18,000,000 plant to be in operation by 1954. Among directors of the new company are Charles E. Wilson (chairman), Robert T. Haslam, Bradley Dewey, and Edwin R. Gilliland, MIT dean of engineering. Plant manager will be John Carriere, manager of engineering and construction at the Hanford AEC works.

Kennecott Copper Corporation has elected Leslie G. Jenness, of the Humko Company, as a vice president. Dr. Jenness will be in charge of research.

The following scientists have joined the staff of Los Alamos Scientific Laboratory: George H. Blount, Edward M. Fryer, and Hugh K. Jennings, physicists; Frederick W. DuBois, chemist; and Kenneth W. Korpi, meteorologist.

The Naval Research Laboratory is completing the construction of additional facilities for research in nuclear physics, the first major expansion since the end of World War II. Two new buildings will provide about 40,000 square feet of space.

Meetings and Elections

The American Academy of Optometry will hold its annual meeting at the Hotel Seneca, Rochester, N. Y., Dec. 6-9. In addition to many special and invited papers, each of five academy sections has arranged its own six-hour program. To celebrate the 100th anniversary of the founding of the Bausch & Lomb Optical Company, a luncheon and special trip through the plant have been arranged for Dec. 9.

The American College of Cardiology is holding a meeting Nov. 7-8 at the Yale University School of Medicine. Three scientific sessions include critical evaluations of electrokymography, micropneumography, and electrocardiography. There will be papers on vector- and ballistocardiography, and other methods of visual and audible registration.

The American Philosophical Society is holding its autumn general meeting Nov. 13-14. Speakers include Henri Marecau, Alan J. B. Wace, Frederick Osborn, George N. Shuster, Herbert F. Goodrich, Thorsten Sellin, Homer A. Thompson, David M. S. Watson, Ralph J. Bunche, Albrecht Goetze, Alexandre Koyré, James G. Baker, Llewellyn Woodward, and Edwin J. Cohn. John E. Doerr, of the National Park Service, will present an illustrated lecture.

The National Science Foundation and the University of Rochester will sponsor an **International Conference on High Energy Nuclear Physics** at Rochester, N. Y., Dec. 18-20. About 70 nuclear physicists from the U. S., Canada, and Mexico will meet to discuss recent developments and to plan future studies. The conference will be under the direction of Robert E. Marshak, and Carl D. Anderson, Enrico Fermi, J. Robert Oppenheimer, Eugene P. Wigner, and Bruno Rossi will preside over various sessions. The conference proceedings will be published within a month after the meetings.

The annual meeting of the **Mineralogical Society of America** will be held Nov. 13-15, in conjunction with the annual meeting of the Geological Society of America, at the Hotel Statler, Boston. The Roebling Medal will be presented to Fred E. Wright, of the Geophysical Laboratory, Washington, D. C., and the Mineralogical Society of America Award to F. H. Stewart, University of Durham, England.

The **Nature Conservancy**, meeting in Ithaca, N. Y., elected the following officers: president, Richard H. Pough, of the American Museum of Natural History; secretary, George B. Fell; AAAS Council members, Herbert C. Hanson, of Catholic University, Washington, and Murray F. Buell, of Rutgers University.

A **Western Forestry Conference** will be held at the Empress Hotel, Victoria, B. C., Dec. 10-12. General theme of the international meeting will be "Forestry by the Acre." For full information, address Stuart Moir, Forest Counsel, 712 U. S. National Bank Bldg., Portland, Ore.

Miscellaneous

The American Society for Metals has established a Foundation for Education and Research, with an initial endowment of \$650,000, for the "advancement and dissemination of scientific knowledge, particularly with respect to the technology of metals." Trustees of the new foundation will be past presidents of the society, rotating in five-year trusteeships dating from their inauguration as presidents. First board consists of Harold K. Work, Arthur E. Focke, Walter E. Jominy, John Chipman, and Ralph L. Wilson. Specific grants will be announced next year.

In a project sponsored by the Society of American Bacteriologists, there is available from the **American Type Culture Collection** the following viruses (v) and Rickettsia (r): *Herpes simplex* (v), influenza A (v), influenza B (v), poliomyelitis, Lansing strain (v), mouse pneumonitis (v), *Vaccinia* (mouse neurotropic) (v), Rickettsialpox (r). Descriptions of the preparations and information on terms for obtaining them will be furnished by the collection, 2029 M St., N.W., Washington 6, D. C.

The **European Council for Nuclear Research** will recommend to its respective governments a 940-acre Swiss site near Lake Geneva for the establishment of a \$25,000,000 atomic study center. The ten nations on the council are France, West Germany, Denmark, Switzerland, the Netherlands, Norway, Italy, Belgium, Sweden, and Yugoslavia. Plans call for the building of a synchro-cyclotron and a proton-synchrotron more powerful than any now in existence.

The **National Science Foundation** has compiled a list of 132 forthcoming international and foreign meetings (through December 1955) of interest to American scientists. A limited number of copies are available upon request from scientists and scientific organizations. Revisions will be published from time to time.

An **Isaac Ray Lectureship** has been established in honor of one of the founders of the American Psychiatric Association. A committee of five Fellows of the association has chosen Winfred Overholser, of Saint Elizabeths Hospital, Washington, D. C., as the first lecturer. He will deliver the lectures at Harvard under the sponsorship of the law and medical school faculties on Nov. 13, 14, 17, and 18.

The **Society of the Sigma Xi** has appointed the following national lecturers: Lee E. Farr, of Brookhaven National Laboratory (discussing "The Impact of Nuclear Science on Medicine" Oct. 16-Nov. 25, Indiana to Honolulu); Curt Stern, of the University of California, Berkeley (discussing "Two or Three Bristles, or the Gene in Development" Oct. 16-Nov. 21, Florida to Indiana); and Wallace R. Brode, of the National Bureau of Standards (discussing "Color and Chemical Constitution" Nov. 3-25, Missouri to California).

Technical Papers

Evaporation of Some Plant Growth Regulators and its Possible Effect on their Activity

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Very minute amounts of growth-regulating compounds may be applied to plants to bring about a variety of responses, such as improving the storage quality of vegetables, preventing fruit drop at harvesttime, and killing undesirable plants. The compound must remain in contact with the plant and be absorbed into its tissues in order to bring about the desired effects. Rate of evaporation is therefore of particular interest, and rapid evaporation is disadvantageous. It is not implied, however, that evaporation of a growth-regulating compound may be altogether undesirable. For example, it is desirable to use one that evaporates readily if the vapors are to be utilized in treating plant material. In the present studies, some carbamates that are used to prevent sprouting of stored vegetables and also as herbicides were found to evaporate at relatively rapid rates at ordinary temperatures. It has been reported that detectable amounts of esters of 2,4-dichlorophenoxyacetic acid evaporate and that their rates of evaporation vary (1, 2).

The rates of evaporation of six plant growth-modifying compounds¹ were studied in the experiments reported here. Three of these, ethyl 2,4-dichlorophenoxyacetate (2,4-D ethyl ester), isopropyl-N-phenyl carbamate (IPC), and 3-chloro-isopropyl-N-phenyl carbamate (3-Cl-IPC), had relatively rapid rates of evaporation. The remaining compounds, 2,4-dichlorophenoxyacetic acid (2,4-D acid), α -naphthalenacetic acid and (4-hydroxy-5-isopropyl-2-methylphenyl)trimethyl ammonium chloride, 1-piperidinecarboxylate (Amo 1618), did not evaporate appreciably under the conditions used.

Several separate experiments were conducted. In a preliminary one, IPC evaporated at an average daily rate of 277 μ g when a relatively large sample (about 7 mg) was spread as a thin layer over an area of about 3 cm² on a watch glass and exposed to air. The sample lost 55% of its original weight when stored for 2 weeks at temperatures of 70°–85° F.

This preliminary result indicated that some carbamates may evaporate rather readily at moderate

temperatures. An additional experiment using IPC and 3-Cl-IPC was therefore done to determine temperatures that are critical in the evaporation of these compounds. The compounds were stored separately in tinfoil cups having sides approximately 3 mm high, each containing about 30 mg of chemical. The area of the bottom of each cup, over which each chemical was spread, was 1.8 cm². The IPC used was in the form of minute but visible crystals, and the 3-Cl-IPC was a liquid. In this experiment loss of weight was determined to the nearest 0.1 mg.

The samples of IPC lost 2, 21, and 25% of their original weight because of evaporation when stored for 2 weeks at temperatures of 60°, 70°, and 85° F, respectively. In contrast, measurable amounts of similar samples stored at 16°, 32°, 40°, and 50° F did not evaporate during this same period. The samples of 3-Cl-IPC stored in a similar manner lost an average of 12% of their original weight at 85° F, but measurable amounts did not evaporate at the other temperatures.

An additional experiment was performed to determine the rate of evaporation of 3-Cl-IPC when a small amount was distributed evenly over a metallic surface. This method was used in order to simulate the amount and surface distribution of plant growth-regulating compounds when applied commercially to the leaves, stems, or fruits of plants. A weighed piece of tinfoil, having a surface area of 30 in.² was dipped into an alcohol solution containing 10,000 ppm of 3-Cl-IPC. After the alcohol had evaporated, 3252 μ g of 3-Cl-IPC was left on the metal—equivalent to about 1.5 lbs of the chemical per acre of surface. When the coated tinfoil was exposed to air at 83°–85° F, the compound evaporated at an average rate of approximately 177 μ g/hr, the loss being most rapid during the first several hours. Under the conditions used most of the 3-Cl-IPC had evaporated by the end of the first 24-hr period of the experiment.

In a similar experiment, the rate of evaporation of Amo 1618, a less well-known carbamate, was also measured. During a 4-day period, there was no measurable loss in weight of the 4651 μ g originally dispersed over the surface of the tinfoil. This indicates that some carbamates do not evaporate as readily as others.

No loss in weight of α -naphthalenacetic acid was detected during the first week after 3300 μ g of the compound was dispersed over the surface of the tinfoil.

The rates of evaporation of 2,4-D acid and of 2,4-D ethyl ester were determined by applying them to glass surfaces in a way comparable to that used in previous experiments with tinfoil. Weighed pieces of glass, each having a surface area of 25 cm², were dipped separately into a solution consisting of 500 mg of either 2,4-D acid or 2,4-D ethyl ester in 50 ml of alcohol. After the alcohol had evaporated there were 343 μ g

¹ Isopropyl-N-phenyl carbamate and 3-chloro-isopropyl-N-phenyl carbamate used were supplied by U. S. Industrial Chemicals Company; (4-hydroxy-5-isopropyl-2-methylphenyl)trimethyl ammonium chloride, 1-piperidinecarboxylate was supplied by the Bureau of Agricultural and Industrial Chemistry, U. S. Department of Agriculture.

of the 2,4-D acid remaining on one piece of glass and 475 μ g of the 2,4-D ethyl ester on the other. During the following 3-day period, there was no measurable loss in weight of the 2,4-D acid sample, but the sample of 2,4-D ethyl ester lost 86% of its original weight. The temperature varied from 79° to 90° F but was about 85° during most of this period.

With the exception of Amo 1618, the rates of evaporation of those chemicals that were previously applied to tinfoil were also measured after they had been applied in a similar manner to glass. The period of evaporation was 24 hr, and the temperature varied from 85° to 88° F. In this experiment, approximately equal amounts of each compound were applied. The carbamate Amo 1618 did not adhere to the surface of the glass, and therefore tinfoil was used in place of glass. Results of these later experiments were similar to the earlier ones with tinfoil. IPC and 3-Cl-IPC both evaporated at a very rapid rate, whereas an appreciable amount of α -naphthalenacetic acid did not evaporate. As would be expected, the 2,4-D ethyl ester

evaporate during the first 24-hr period following its application unless it penetrated into the tuber. Temporary storage at low temperatures apparently allowed time for the tubers to absorb an effective amount of the compound before it evaporated.

Some growth-regulating substances are effective when applied to plants in minute amounts, even at relatively high temperatures, since they apparently do not evaporate at a sufficient rate to reduce their effectiveness. For example, apple drop, which sometimes occurs before harvest, may be greatly reduced by the application of sprays that contain only 10 ppm α -naphthalenacetic acid. In supplementary experiments the acid was applied at this rate to mature apples, and the fruits retained an average of only about 4 μ g of the chemical.

Stevens and Carlson (5) reported that temperatures below 75° F markedly delayed the disappearance of 3-chloro-isopropyl-N-phenyl carbamate following its application to soil. It would appear from the present results that, when growth-regulating compounds such as IPC and 3-Cl-IPC are used as herbicides at high temperatures, they may evaporate in sufficient amounts to reduce their effectiveness.

TABLE 1
EVAPORATION OF SOME GROWTH-REGULATING COMPOUNDS
DURING THE FIRST 24-HR PERIOD AFTER BEING
FINELY D:SPERSED ON GLASS SLIDES
HAVING A SURFACE AREA
OF 25 CM²

| Compound | Temperature range (°F) | Amount used (μ g) | Percentage evaporation in 24 hr |
|---------------------------------|------------------------|------------------------|---------------------------------|
| 3-Cl-IPC | 85-88 | 364 | 91.9 |
| IPC | 85-88 | 382 | 79.6 |
| 2,4-D ethyl ester | 79-90 | 475 | 29.0 |
| α -Naphthalenacetic acid | 85-88 | 492 | 5.5 |
| 2,4-D acid | 79-90 | 343 | 0 |
| Amo 1618* | 79-90 | 4651 | 0 |

* Amo 1618 applied to tinfoil instead of glass.

evaporated, and the 2,4-D acid failed to do so. On the other hand, the ethyl ester did not evaporate nearly as fast as did either the IPC or the 3-Cl-IPC (Table 1).

These experiments show that certain carbamates evaporate at a relatively rapid rate at moderate or comparatively high temperatures. This would seem to indicate that when they are applied in small amounts their effectiveness as plant growth regulators might be reduced through rapid evaporation. Rhodes *et al.* (3) reported that the sprout-inhibiting effect of isopropyl-N-phenyl carbamate decreased when treated potato tubers were exposed to air. Marth and Schultz (4) reported that relatively small amounts of 3-Cl-IPC inhibited the sprouting of potatoes stored at room temperatures, but only when the treated tubers were temporarily stored at low temperatures (40°-50° F) prior to storage at the higher temperatures (about 70°-75° F). In their experiments an average of approximately 4.5 mg of the 3-Cl-IPC was applied per tuber. It would be expected, on the basis of the present results, that practically all of this would

References

1. MARTH, P. C., and MITCHELL, J. W. *Botan. Gaz.*, **110**, 632 (1949).
2. MULLISON, W. R., and HUMMER, R. W. *Ibid.*, **111**, 77 (1949).
3. RHODES, A., *et al. Research*, **3**, 189 (1950).
4. MARTH, P. C., and SCHULTZ, E. S. *Am. Potato J.* (in press).
5. STEVENS, L. F., and CARLSON, R. F. *Proc. 6th Ann. North-eastern Weed Conf.*, **33** (1952).

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The Antithyroid Activity of some Compounds that Inhibit Peroxidase

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The percutaneous absorption of resorcinol has been reported to induce myxedema with goiter in human subjects (1), and the parenteral administration of this substance to the rat acutely depressed the accumulation of radioactive iodine by the thyroid gland (2). In a recent study of many polyhydric phenols Arnott and Doniach (3) showed that compounds containing hydroxyl groups *meta* to one another (e.g., resorcinol, phloroglucinol, hydroxyhydroquinone) were most effective in decreasing iodine uptake by the rat thyroid, and these authors suggested, on the basis of an earlier observation of an inhibitory action of resorcinol on milk peroxidase (4), that the antithyroid effect of substances of this kind might be ascribed to inhibition of a thyroid peroxidase. Their report prompts us to record experiments along similar lines performed in

this laboratory. The effects, described below, of certain phenols and amines on peroxidase activity and thyroid function lend support to the view that peroxidase inhibitors have antithyroid effects and, by implication, favor the concept that a thyroid peroxidase may be concerned with the organic binding of iodine.

The assay of antithyroid effect was performed by the method of McGinty (5). The test substance, in aqueous or dilute ethanol solution, was injected subcutaneously in rats weighing 100-150 g; 1 hr later, 6-8 μ e I^{131} was administered intraperitoneally, and 4 hr after this the animals were killed, the thyroids removed and dissolved in hot NaOH. The radioactivity was determined by γ -ray counting of the liquid sample (6). The results for each compound were expressed as a percentage of the uptake in control animals run simultaneously. The effect of some of the compounds on peroxidase was studied by a modification of Randall's manometric procedure (7). The enzyme was prepared from raw milk by Elliot's method (8) and dried from the frozen state after removal of salts by dialysis; aqueous solutions were made before use. A mixture of enzyme, substrate (*p*-phenylenediamine, catechol, or benzidine in final concentration 0.003 *M*), hydrogen peroxide (.003 *M*) in phosphate buffer (pH 6.8) was incubated in the main compartment of Warburg vessels with and without test compounds, which were used in concentration 3-20% of the substrate; after 5-15 min catalase was tipped in from the side arm, and residual peroxide was thus determined. Qualitative tests of the antiperoxidase effect were also made by adding equal volumes of a peroxidase-peroxide-buffer solution to each of a series of tubes containing progressive tenfold dilutions of the test substance; after a few minutes a starch-iodide solution was added and the rate of iodine color development observed.

The effects of the test substances on thyroid uptake of I^{131} are indicated in Table 1. The considerable inhibitory effect of phloroglucinol confirms the observation of Arnott and Doniach (3); the much less marked effect of resorcinol noted in the present studies may be related to the longer time interval between injection of the compound and sacrifice of the animal. Phenol, catechol, pyrogallol, α -naphthol, and vanillin did not depress thyroid uptake of radioactive iodine. Among the amines tested, *m*-phenylenediamine, in contrast to the *o*- and *p*-isomers, exhibited marked antithyroid effect. The toxicity of *p*-phenylenediamine (10-15 mg being a fatal dose) precluded its use in dosage comparable to the other isomers. *p*-Aminophenol did not inhibit uptake, whereas *m*-aminophenol did so strikingly, and, similarly, 4- but not 5-aminosalicylic acid decreased thyroid I^{131} accumulation. The amino-analog of phloroglucinol was somewhat less effective than the latter compound. Aniline and the three isomeric toluidines induced great depression of iodine uptake.

The ratio of I^{131} concentration in thyroid and serum of animals pretreated with propylthiouracil and then receiving phloroglucinol or aniline did not differ from

TABLE 1*

| | No. of rats | Dose (mg/rat) | Thyroid I^{131} accumulation % of controls | Inhibition of peroxidase |
|--|-------------|---------------|--|--------------------------|
| Resorcinol | 3 | 2 | 76 | ++ |
| | 4 | 10 | 50 | |
| | 2 | 25 | 74 | |
| Phloroglucinol | 3 | 2 | 25 | ++ |
| | 4 | 5 | 26 | |
| | 2 | 25 | 14 | |
| Pyrogallol | 3 | 7 | 90 | - |
| | 4 | 8 | 94 | |
| | 2 | 25 | 95 | |
| <i>m</i> -Phenylenediamine dihydrochloride | 2 | 2 | 32 | ++ |
| | 3 | 5 | 53 | |
| | 3 | 25 | 6 | |
| | 3 | 30 | 13 | |
| <i>p</i> -Phenylenediamine dihydrochloride | 2 | 2 | 84 | - |
| | 3 | 6 | 76 | |
| <i>o</i> -Phenylenediamine dihydrochloride | 3 | 25 | 64 | - |
| <i>m</i> -Aminophenol | 5 | 25 | 10 | + |
| <i>p</i> -Aminophenol | 5 | 25 | 93 | - |
| 4-Aminosalicylic acid | 5 | 25 | 34 | + |
| 5-Aminosalicylic acid | 3 | 25 | 122 | - |
| 1,3,5-Triaminobenzene hydrochloride | 2 | 10 | 48 | |
| | 3 | 15 | 39 | |
| Aniline | 3 | 20 | 7 | ++ |
| <i>m</i> -Toluidine | 5 | 25 | 14 | ++ |
| <i>o</i> -Toluidine | 5 | 25 | 12 | + |
| <i>p</i> -Toluidine | 3 | 25 | 10 | ++ |

* In the last column, (-) indicates no inhibition, (+) and (++) indicate, respectively, moderate and marked inhibition.

that of controls receiving propylthiouracil alone, indicating that these substances inhibit organic binding of iodine by the thyroid and do not affect the iodide-concentrating mechanism.

The peroxidase experiments showed that resorcinol, phloroglucinol, *m*-aminophenol, *m*-phenylenediamine, 4-aminosalicylic acid, aniline, and the toluidines significantly inhibited the enzymic oxidation of the substrate. Although *o*-toluidine was a substrate for peroxidase as judged by color development, the compound decreased the rate of peroxide disappearance when *p*-phenylenediamine or catechol was present as a substrate. Those substances mentioned above which did not inhibit thyroidal iodine accumulation (phenol, catechol, pyrogallol, 5-aminosalicylic acid, vanillin) appeared to be good substrates of peroxidase. The studies of Balls and Hale (9) disclosed a number of substances, some generally considered to be substrates of vegetable peroxidase, which in the presence of peroxide decreased the activity of the enzyme preparations. It is of interest that among peroxidase inhibitors they listed aniline, phloroglucinol, *m*- and *p*-toluidine, and resorcinol, compounds which have marked antithyroid activity. The *meta* configuration, in the case of polyphenols and amines, would appear to be particularly active in both respects.

It is thus a curious fact that most classes of anti-thyroid substances are either competitive substrates or inhibitors of peroxidase, the thiocarbonamides being in the former category (7) and sulfonamides (10), anilines, and polyphenols in the latter.

References

1. BULL, G. M., and FRASER, R. *Lancet*, **258**, 851 (1950).
2. DONIACH, I., and FRASER, R. *Ibid.*, 855.
3. ARNOTT, D. G., and DONIACH, I. *Biochem. J.*, **50**, 473 (1952).
4. ELLIOT, K. A. C. *Ibid.*, **26**, 1281 (1932).
5. MCGINTY, D. A., et al. *J. Pharm. Exptl. Therap.*, **93**, 246 (1948).
6. RABEN, M. S. *Anal. Chem.*, **32**, 246 (1950).
7. RANDALL, L. O. *J. Biol. Chem.*, **164**, 521 (1946).
8. ELLIOT, K. A. C. *Biochem. J.*, **26**, 10 (1932).
9. BALLS, A. K., and HALE, W. S. *J. Biol. Chem.*, **107**, 767 (1934).
10. LIPMANN, F. *Ibid.*, **139**, 977 (1941).

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Ascorbic Acid and Physiological Breakdown in the Fruits of the Pineapple (*Ananas comosus* L. Merr.)

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Many tropical fruits may be injured when they are stored too long at temperatures in the range of 0°-10° C. The injury is often called "chilling," and it is usually characterized by a darkening of the flesh or of the peel and by failures of the mature green fruits to ripen properly when they are subsequently stored at room temperature. Specific effects on flavor and chemical constituents may also appear, depending upon the particular kind of fruit involved.

The exact manner in which chilling modifies the normal metabolism of tropical fruits is not entirely understood, although several investigators have contributed valuable information to the subject. Jones (1), in his studies of the papaya, found that ripening changes (especially hydrolysis of sucrose) were retarded by low temperatures, and the effect on respiration was so marked as to suggest that the basic metabolism of the fruit was upset. Harris and Poland (2) reported a loss of ascorbic acid in chilled bananas, but the fruits had been severely injured by exposure to low temperatures, so that these particular changes may have been largely the result of autolysis of the cells. It was previously reported by the senior author (3) that two lots of imported pineapples showing physiological breakdown were characterized by a lower content of ascorbic acid than was true of normal fruits. These fruits showed advanced stages of physiological breakdown, and, as in the experiments of Harris and Poland, the destruction of ascorbic acid may have occurred during autolysis rather than in the earlier stages of exposure to low temperatures. The results that are now being reported were obtained by analyzing pineapples which had been stored at low temperature but which had not shown visible evidence of

TABLE 1
EFFECT OF COLD STORAGE ON CERTAIN CONSTITUENTS OF THE JUICE OF THE ABACHI PINEAPPLE

| Treatment | Bromelin activity (1/t) | Total soluble solids (%) | Total acid (g/100 ml) | Ascorbic acid (g/100 ml) |
|--|-------------------------|--------------------------|-----------------------|--------------------------|
| Stored at room temperature | 0.377 | 12.9 | 0.98 | 42.4 |
| Stored at 6° C for 1 wk, then at room temperature for 2 days | 0.363 | 11.5 | 0.79 | 25.9 |

physiological breakdown when the fruits were sampled.

Abachi pineapples were grown in Florida, harvested in the "mature green" or "market ripe" stage of maturity and shipped to Pittsburgh, Pa., by railway express. Upon arrival at destination the fruits were divided into two lots, each comparable to the other in regard to stage of maturity of the individual fruits. One lot was held at room temperature (25°-30° C) for 2 days and then analyzed. The other lot was stored at 6° C for 1 week and then held at room temperature for 2 days before analyzing. Each fruit was sampled individually in order to facilitate statistical interpretation of the results. The expressed and filtered juice was analyzed for total soluble solids, total acids, ascorbic acid, and bromelin activity. Each lot consisted of 10 pineapples. The averaged results appear in Table 1.

The two lots did not differ significantly in regard to total soluble solids, total acids, and bromelin activity of the juice, but a highly significant difference in ascorbic acid was observed. The refrigerated lots of pineapples contained 25.9 mg ascorbic acid/100 ml juice, compared to 42.4 mg in the control fruits. This amounts to a reduction of 38.9%.

The pineapples showed no ill effects of the cold storage other than this loss of ascorbic acid. There was no discoloration of the flesh and no deleterious effect on flavor. In other words, the period of storage was interrupted before any visible symptoms of chilling had appeared, and it is concluded that destruction of ascorbic acid constitutes the first phase in the development of low-temperature injury.

This does not explain all that occurs when tropical fruits are injured by exposure to low temperatures. It does suggest that such a treatment interferes with a specific step in the respiratory processes of the plant cell. It is known, for example, that in one stage of respiration certain phenolic compounds are oxidized to quinones, the latter being black or brown in color. During the normal course of the process quinones are converted back to phenols by ascorbic acid. This reversible action continues as long as an adequate supply of ascorbic acid is present. Since physiological breakdown of pineapples is characterized by a darkening of the flesh, it seems logical to conclude that the discoloration in the affected fruits indicates that the

above-mentioned oxidation-reduction has been stopped in the quinoid stage. The same explanation may be applicable to low-temperature injuries of other tropical fruits, although our results have been obtained only with pineapples. The fact that immature fruits are more susceptible to low-temperature injuries than mature fruits tends to confirm the theory, because of the larger content of phenols in the form of soluble tannins in the immature fruits.

References

1. JONES, W. W. *Plant Physiol.*, **17**, 481 (1942).
2. HARRIS, P. L., and POLAND, G. L. *Food Research*, **4**, 317 (1939).
3. MILLER, E. V. *Plant Physiol.*, **26**, 66 (1951).

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Experimental Production of Hyperkeratosis ("X Disease") of Cattle with a Chlorinated Naphthalene¹

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The baffling and costly malady known as X disease of cattle was first recognized in New York state and described by Olafson (1) in 1947. It has been recognized since that time in all states east of the Rocky Mountains, and the Southeastern states seem to have a higher incidence of diseased herds than any other section of the country. In Tennessee alone more than 2300 head of cattle have been affected since 1947. Valuable purebred herds have been affected, and the raising of calves in some herds became impossible over a three-year period. Such diseased herds were slaughtered.

Olson and Cook (2) produced the disease in cattle by using a commercially prepared feed that had been incriminated in an outbreak of the disease in a herd in Nebraska. Wagener (3) produced it in Germany by exposing cattle to a complex wood preservative used in the construction of a new barn. Olafson and McEntee (4) also produced the disease by feeding cattle a processed concentrate, and Bell (5) infected calves by feeding them a lubricant. None of these workers has identified the specific chemical compound or compounds that produced the disease.

This experiment was designed to use a known chemical compound, which may be used on many farms in many different ways, and the effect of which was unknown on the bovine. There is no reference in the literature to its having been administered to cattle. Thus the experiment, in the early stages, was one of trial and error to find a toxic dose which would not produce immediate death but which would make the animal ill.

¹ A contribution from the Interregional project entitled "X Disease (Hyperkeratosis of Cattle), a Cooperative Study Participated in by the Agricultural Experiment Stations and the Bureau of Animal Industry, U. S. Department of Agriculture."

Two grade Hereford females, one year old and weighing about 500 pounds each, and one Jersey Hereford crossbred female, eight months old and weighing about 400 pounds, were used in the tests. Pentachloronaphthalene was used in the experiment and administered *per os* in capsules each day. The control animal of comparable size and age remained healthy throughout the experiment.

TABLE 1

| No. days dosed | Dose/day (g) | Grams pentachloronaphthalene for entire period |
|----------------|--------------|--|
| 10 | 2 | 20 |
| 10 | 4 | 40 |
| 10 | 6 | 60 |
| 10 | 8 | 80 |
| Total 40 | | 200 |

Hereford No. 748 was used as a pilot test to try to find the amount necessary to cause death when administered over a two-week period. This animal received 15 g/day for 13 days and was sacrificed on the 17th day because of its morbid condition. With this acquired knowledge of the toxicity and the amount necessary to cause death in 17 days, the other two animals were dosed according to Table 1.

Symptoms observed were identical with those seen in naturally occurring field cases. They included excessive lacrimation, diarrhea, polyuria, marked salivation, and a serous discharge from the nostrils. A chronic cough, poor appetite, and numerous red macules in the buccal cavity developed later. Some of the macules became 30 mm in diameter, with proliferations of the underlying tissues. By the 35th day hyperkeratosis of the skin had developed on the sides of the neck, across the withers, and around the mammary gland. The skin was dry, hard, stiff, and thrown up in rolls, which later developed fissures (Fig. 1).



FIG. 1. Note rolls of skin with fissures on side of neck of animal No. 706.

At autopsy there were numerous proliferative areas on the gums, lips, and hard palate. The abomasum had numerous superficial ulcers 10–20 mm in diameter in the pyloric region. The pancreas was swollen, hard, and firm. The liver edges were rounded and slightly thickened. The distended gall bladder was filled with a dark, sticky, viscid bile, and the walls were thickened. Numerous mucous cysts were observed in the large bile ducts. The kidneys were enlarged, and numerous small subcapsular, clear cystlike structures were seen in the cortical portion.

Microscopically the cellular changes observed are similar to those seen in field cases and those reported by other workers. Marked keratinization of the hair follicles, with an excessive accumulation of keratinized material, along with a prolongation of the papillae of the skin, was noted. Central lobular degeneration of the liver cells, with bile duct proliferations, was evident. Dilatation of the glands in the wall of the gall bladder was pronounced. In the kidneys, cystic dilatation of the collecting tubules of the cortex, with a moderate degree of fibrosis, occurred. In the pancreas numerous areas of degenerating cells in the acini were also noted. A more complete and detailed report concerning these and other pathological changes is to be published later.

References

1. OLAFSON, P. *Cornell Vet.*, **37**, 195 (1947).
2. OLSON, C. JR., and COOK, R. H. *Am. J. Vet. Research*, **12**, 261 (1951).
3. WAGENER, K. J. *Am. Vet. Med. Assoc.*, **119**, 133 (1951).
4. OLAFSON, P., and MCENTEE, K. *Cornell Vet.*, **41**, 107 (1951).
5. BELL, W. B. *Virginia J. Sci.*, **3**, 77 (1943).

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Effect of Renin on Diuresis in Rats

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Croxatto *et al.* (1), using renin obtained from rat kidney, confirmed in this species the diuretic effect of renin that had been observed in rabbits by Pickering and co-workers (2) and under other conditions by Brandt *et al.* (3), Hughes-Jones *et al.* (4), Addis *et al.* (5), Mason *et al.* (6), Sellers *et al.* (7), and Barnafi (8). This study was undertaken to investigate the conditions that affect the influence of renin in the rat—e.g., the route of administration, the ingestion of NaCl, and adrenalectomy. Some of the experiments were carried out in normally hydrated animals with free access to water. In others the animals were hyperhydrated by forced administration of water, as described by Burn (9).

The normally hydrated animals (a total of 160), distributed in groups of 3 or 4 animals, were placed in metabolism cages, and the fluid consumption and the volume of urine excreted were measured every

12 hr. The results were recorded for periods of 10–40 days, depending on the experiment. The drinking fluid was either water or a 1% solution of NaCl. Renin and the other solutions administered were injected once a day intraperitoneally or subcutaneously, as indicated in Table 1.

The hyperhydration of rats was carried out under the conditions required for the Burn test (9). One group of rats was fasted with free access to water and then hyperhydrated by administering water through a gastric tube; the volume administered was 5% of body weight. The urine volume was recorded every 15 min. The injection of renin or other solutions was simultaneous with the hydration or preceded it by 1, 2, 3, 4, or 5 hr (Table 2).

Renin was extracted from pig, rat, or human kidney according to the techniques of Dexter (10) or Braun-Menéndez (11); 12.5–25 u of renin contained in 0.5–1 ml of solution was injected/100 g body weight. An inactive preparation (Ser. B) from pig kidney, as shown by its lack of pressor effect and its inability to produce hypertensin when incubated with hypertensinogen, was also tested. In some experiments (Ser. D, Table 1) hypertensin, at a dose of 1.5–9 u/rat, was injected in place of renin. Animals submitted to this treatment for more than 30 days were killed, and the hypertensinogen content of their blood was determined.

In normally hydrated rats drinking tap water (Ser. A, Table 1) the intraperitoneal administration of renin considerably increased urinary excretion, whereas the same dose of renin given subcutaneously modified it slightly or not at all (Fig. 1).

The stimulating effect on diuresis is observed after each injection of renin, but it decreases with repeated injections. This behavior could be explained by the formation of antirenin on prolonged administration of renin. In agreement with this assumption, we found that the serum of these rats does not produce hypertensin when incubated with renin, but produces peptsin when incubated with pepsin. This indicates that there is no lack of substrate (hypertensinogen), but that an inhibitor of renin is present.

Inactive kidney extracts never stimulated diuresis, no matter what the dose or the route of administration (Ser. B, Table 1).

The diuretic action of renin is considerably increased in animals drinking 1% NaCl (Fig. 1). Pronounced effects are observed even when renin is administered subcutaneously (Ser. C, Table 1).

Hypertensin does not show a diuretic effect even at a dose of 9 u; only weak and irregular effects were obtained with larger doses given subcutaneously (Ser. D, Table 1).

Adrenalectomy in rats drinking 1% NaCl considerably decreased or suppressed the stimulating effect on diuresis produced by daily intraperitoneal injections of renin. A dual effect of renin was observed in the polyuria of normal hyperhydrated animals

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TABLE 1
EXPERIMENTS ON NORMALLY HYDRATED RATS

| Series | Group* | Drinking fluid | Injected with | Route of injection | Intensity of diuretic effect† |
|--------------------|--------|----------------|----------------|--------------------|-------------------------------|
| A—normals | a | Water | Renin‡ | Intraperitoneal | ++ |
| | b | " | " | Subcutaneous | 0 |
| | c | " | 0.9% NaCl | Intraperitoneal | 0 |
| B—normals | a | Water | Renin | Intraperitoneal | ++ |
| | b | " | Inactive renin | " | 0 |
| C—normals | a | 1% NaCl | Renin | Intraperitoneal | +++ |
| | b | " | " | Subcutaneous | + |
| | c | " | 0.9% NaCl | " | 0 |
| D—normals | a | Water | Hypertensin‡ | Intraperitoneal | 0 |
| | b | " | " | Subcutaneous | 0 + (?) |
| E—adrenalectomized | a | 1% NaCl | Renin | Intraperitoneal | 0 |
| | b | " | 0.9% NaCl | " | 0 |

* Each group composed of 3 rats.

† 12.5–25 u of renin injected/100 g body weight.

‡ 4.5 u of hypertensin injected/100 g body weight.

§ 0 indicates no effect in the 12 hr following injection; + indicates the intensity of the diuretic effect by comparison with the periods in which the animals were not injected with renin.

(Ser. F, Table 2). Water excretion is slowed down when the overloading with water is produced immediately after or within 1 hr following the intraperitoneal injection of renin. This antidiuretic effect decreases rapidly, and in rats hyperhydrated 2, 3, and 5 hr after the injection the effect is reversed, resulting in a considerable and progressive increase in water excretion (Fig. 2).

In adrenalectomized rats (Ser. G and H, Table 2)

TABLE 2
EXPERIMENTS ON HYPERHYDRATED RATS

| Series | Group* | Drinking fluid | Intensity of diuretic effect† |
|-------------------------------|--------|----------------|-------------------------------|
| F—normals | 0 | Water | — |
| | 1 | " | — |
| | 2 | " | (±) + |
| | 3 | " | +++ |
| | 4 | " | ++ |
| G—adrenalectomized (5 days) | 0 | NaCl | — |
| | 1 | " | — |
| | 2 | " | — + (?) |
| | 3 | " | — |
| | 4 | " | — |
| H‡—adrenalectomized (30 days) | 0 | NaCl and water | — |
| | 1 | " " " " | — |
| | 2 | " " " " | — |
| | 3 | " " " " | — |
| | 4 | " " " " | — |

* Each group composed of 3 rats. The number of the group indicates the time (in hr) after intraperitoneal injection of renin (12.5 u/100 g body weight) at which the animals were hydrated. The amount of water given by stomach tube was 5% of body weight. The controls injected with 0.9% NaCl and "inactive" renin are not shown in the table.

† 0, +, and — indicate whether the volume of urine excreted was the same or greater or lower than in the animals injected with 0.9% NaCl.

‡ Composed of rats adrenalectomized 30 days before the experiment and drinking 1% NaCl solution for 27 days, followed by tap water.

hyperhydrated 2 and 5 hr after intraperitoneal injection of renin, a marked delay in water excretion is observed as compared to normal animals under the

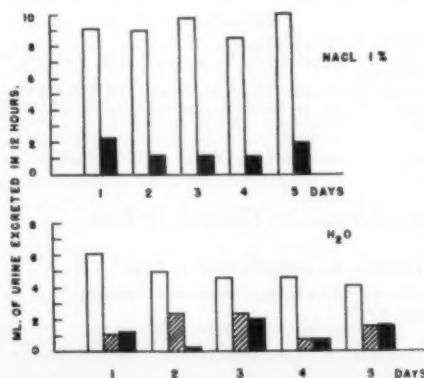


FIG. 1. Urine volume (ml) per 100 g body weight and 12 hr, in the first 5 days of the experiment. Each bar represents the average for 6 rats. Upper part of graph refers to animals drinking 1% NaCl. White bars refer to rats injected intraperitoneally daily with 0.5 ml pig renin/100 g body weight, and the black bars to those injected with 0.9% NaCl. Lower portion of graph refers to diuresis of rats drinking tap water. White bars refer to rats injected intraperitoneally with 0.4 ml renin/100 g body weight, hatched bars to those that received the same dose subcutaneously, and black bars to those injected intraperitoneally with 0.9% NaCl.

same conditions or to adrenalectomized rats injected with 0.9% NaCl instead of renin (Fig. 3). Some of the adrenalectomized animals, drinking 1% NaCl for a prolonged period, show a more active diuresis when hyperhydrated 2 hr after renin injection, but never reach the high level of excretion of normal animals.

Renin was injected into rats (adrenalectomized 20–30 days before, Ser. H, Table 2) 2–4 days after the drinking of 1% NaCl solution was discontinued. The

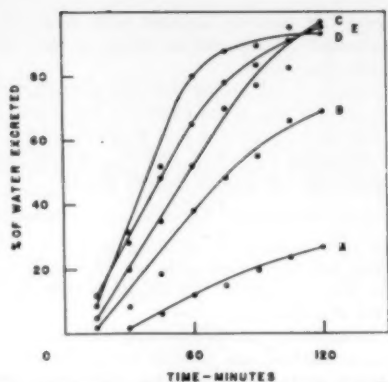


FIG. 2. Percentage of urine volume excreted by 4 normal rats as related to the amount of water administered by stomach tube (5% of body weight, Burn test [9]). All animals were injected intraperitoneally with 0.5 ml renin/100 g of body weight. A corresponds to the group of rats simultaneously injected and hydrated; B, to the group hydrated 1 hr after renin injection; C, 2-hr interval; D, 3-hr interval; E, 4-hr interval.

injection was given 2 hr before water overloading and was followed by a marked antidiuretic effect. This effect was greater than that observed in normal rats injected with the same dose of renin simultaneously with water overloading.

The results obtained with normally hydrated animals (Ser. A, B, and C, Table 1) demonstrate the effects of renin on water metabolism and urinary excretion, which depend on the route of administration and the amount of NaCl in the drinking water. These effects appear to be related to the ability of renin to react with hypertensinogen, but hypertensin

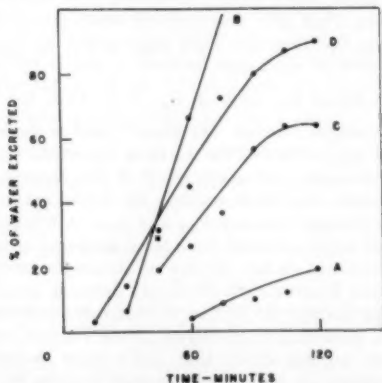


FIG. 3. Percentage of urine volume excreted by normal and adrenalectomized rats, as related to the amount of water administered by stomach tube (5% of body weight, Burn test [9]). A corresponds to 4 adrenalectomized rats, injected with 0.5 ml renin/100 g body weight; B, normal rats injected with same dose of renin; C, 4 adrenalectomized rats injected with 0.9% NaCl; D, normal rats injected with 0.9% NaCl. All animals injected intraperitoneally with renin or NaCl 2 hr prior to water administration by stomach tube. Normal and adrenalectomized rats drank 1% NaCl for 4 days before injection.

does not seem to be the responsible factor (Ser. D, Table 1).

The greater diuretic effect of renin on the rats drinking NaCl solution is a confirmation of the probable relation of this effect with sodium excretion (2, 7).

The absence or slight stimulation of diuresis by renin on adrenalectomized rats with free access to water (Ser. E, Table 1) is a demonstration of the importance of the integrity of the adrenal function for this effect. The results obtained in hyperhydrated rats is a confirmation of the same findings (Ser. G, Table 2).

The analysis of the results of the studies on water excretion in normal rats hyperhydrated at different intervals after renin injection indicates that the effects on diuresis are complex. Two phases may be considered. The immediate effect, lasting $\frac{1}{2}$ -1 hr, is an inhibition of diuresis, followed by a more prolonged phase from the second to the fifth hour after intraperitoneal injection of renin, characterized by an acceleration of water excretion.

In adrenalectomized hyperhydrated rats, particularly those deprived of NaCl, renin shows only the antidiuretic effect lasting several hours, indicating that intact adrenal function or a normal NaCl balance is required for the diuretic action to appear.

The increase in diuresis produced by renin is independent of the changes in blood pressure. The intense effect of renin injection on diuresis supports the views of Fasciolo (12) and Brandt *et al.* (3) in attributing a more important role to this kidney enzyme in water metabolism. On the other hand, more recent studies seem to indicate that a closer relationship exists between the hormonal hypertensive mechanism and water and NaCl balance. Renin might be a common factor for both processes.

We cannot explain the difference in action of renin when given intraperitoneally or subcutaneously; but it is possible that, in addition to a difference in the rate of absorption or destruction of renin, some intrahepatic mechanism may be at work when renin is given intraperitoneally. It is difficult to decide at present whether the antidiuretic and diuretic effects of renin are due to the enzyme itself or to impurities, or to some other specific substance produced by the enzyme, as is the case for the antidiuretic factor obtained in the reaction of hypertensinogen with pepsin (13). In any case, hypertensin is not responsible for the polyuria produced by renin when given intraperitoneally to the rat. The possible influence of renin on the secretory mechanisms of the hypophysis and the adrenal are under study.

References

1. CROXATTO, H., BARNAFI, L., and VILLAGRA, A. *Bol. soc. biol. Santiago Chile* (in press).
2. PICKERING, G. W., and PRINZMETAL, M. *J. Physiol. (London)*, **96**, 314 (1940).
3. BRANDT, L., and GRUHN, J. *Am. J. Physiol.*, **153**, 458 (1948).
4. HUGHES-JONES, N. C., *et al. J. Physiol. (London)*, **109**, 288 (1949).

5. ADDIS, T., et al. *J. Exptl. Med.*, **89**, 131 (1949).
6. MASSON, G., CORCORAN, A., and PAGE, I. *Am. J. Physiol.*, **162**, 379 (1950).
7. SELLERS, A., et al. *Ibid.*, **166**, 619 (1951).
8. BARNAFI, L. Personal communication.
9. BURN, H. J. *Quart. J. Pharm. Pharmacol.*, **4**, 517 (1931).
10. DEXTER, L., HAYNES, F. W., and BRIDGES, W. C. *J. Clin. Invest.*, **24**, 82 (1943).
11. BRAUN-MENÉNDEZ, E., et al. *Hipertensión Renal*. Buenos Aires (1943).
12. FASCIOLIO, J. C. *Acta Physiol. Latin Am.*, **1**, 7 (1951).
13. CROXATTO, H., ROJAS, G., and BARNAFI, L. *Ibid.*, 179.

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Mapping Functions in Tetrad and Recombinant Analysis

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In the ascomycetes and basidiomycetes, all four products of a single meiosis can be isolated and characterized. Data so obtained possess obvious advantages in precision and statistical efficiency over those provided by the usual genetic material, which involves random sampling of single strands. In particular, the analysis of tetrads offers a sensitive method for examining the details of the meiotic process.

Various methods have been proposed for employing tetrad data in the mapping of loci. Whitehouse (1) and Mather and Beale (2) have provided a careful and exhaustive analysis of the information available in those cases (e.g., *Neurospora crassa*, *Bombardia lunata*) in which the linear order of the segregants is known.

The problem of mapping in the more general and widespread situation of unordered spore arrays has been considered by Lindegren (3), who developed a graphical method.

A less cumbersome and inherently more accurate approach was made possible by an analytic solution to the problem. To aid in the subsequent discussion we shall adopt the following symbolism: P_{AO} , P_{BO} , etc., will denote the frequencies of M II segregations of the loci, A , B , etc. which result from crossovers occurring between the locus concerned and its centromere; P_{AB} will signify the frequency of M II segregations of A and B to yield tetratype asci; p_{AB} will denote the recombinant frequency between A and B .

Perkins (4) and Whitehouse (5) noted that in the cross $AB \times ab$, the frequency of tetratype asci (i.e., AB , Ab , aB , ab) is given by

$$P_{AB} = P_{AO} + P_{BO} - \frac{3}{2} P_{AO} P_{BO}, \quad (1)$$

if A and B are independent. Perkins (4) pointed out that with the aid of another locus, C , not linked to either A or B , equations analogous to (1) can be written for P_{AC} and P_{AB} . The resulting set of three simultaneous equations may then be solved for P_{AO} , P_{BO} , and P_{CO} , as was done by Whitehouse (6). The

three genes can thus be localized with reference to their respective centromeres in terms of their M II segregation frequencies.

It is perhaps worth noting that this procedure cannot be applied if two of the three loci are linked and in the same arm. Thus, if A and B are so linked, the three probabilities P_{AB} , P_{AC} , and P_{BC} are no longer independent and one obtains instead of (1)

$$P_{AB} = \frac{P_{BO} - P_{AO}}{1 - \frac{3}{2} P_{AO}}, \quad (2)$$

which does not form a solvable set of simultaneous equations with the other two relations that can be written for P_{AC} and P_{BC} .

Data obtained by the proper application of these or analogous methods can provide consistent information in terms of distances from the centromere. Difficulty arises, however, when it becomes necessary to compare such map distances with those obtained by the conventional method, which depends on the frequency of recombinant strands. It has been assumed by the authors mentioned above, as well as by others, that

$$p_{AB} = \frac{1}{2} P_{AB}, \quad (3)$$

where, as above, p_{AB} refers to recombinant frequency between A and B and P_{AB} the corresponding M II frequency.

The reasoning often offered to justify this conversion is that only one half of all crossovers that occur are observed in ordinary recombinant analysis, since only one chromatid out of any given tetrad is recovered. Although they employ this conversion factor, both Rizet and Engelmann (7) and Papazian (8) have pointed out that it at best represents an approximation which can be valid only over short map distances. That this contention is correct is evident from the fact that the limit approached by p_{AB} as the number of chiasmata between A and B increases is $1/2$, whereas the limit of P_{AB} is $2/3$. Thus for long map distances relation (3) would yield a value of 0.33 for p_{AB} instead of the 0.5 to be expected.

The accurate conversion of M II frequencies into recombinant map units requires the derivation of the explicit relation between P_{AB} and p_{AB} . A relation of this kind can be obtained from the corresponding mapping functions. In the absence of chiasmata interference, these functions can be simply deduced, since for any fixed average the number of chiasmata will be distributed according to the terms of the Poisson series. Haldane (9) has shown that under these conditions the frequency of recombinant strands is given by

$$p_{AB} = \frac{1}{2} (1 - e^{-2m'}) \quad (4)$$

where m' is the average number of chiasmata per two strands occurring between the relevant loci. Mather (10) has demonstrated that the proportion of a set of tetrads which will exhibit M II segregation if each tetrad has experienced precisely r chiasmata between A and B is given by

$$P_{AB}(r) = \frac{2}{3} \left[1 - \left(-\frac{1}{2} \right)^r \right]. \quad (5)$$

As Rizet and Engelmann (7) pointed out, to convert Eq (5) to a mapping function analogous to (4), Haldane's assumption of a Poissonian distribution must be adopted. Consider a set of tetrads in which an average of m chiasmata has occurred between A and B per tetrad. The fraction which will have experienced precisely r chiasmata in this region will be given by $\frac{m^r}{r!} e^{-m}$. Consequently, the fraction P_{AB} which will exhibit M II segregations between A and B will be given by

$$P_{AB} = \sum_{r=0}^{\infty} \frac{m^r}{r!} e^{-m} P_{AB}(r). \quad (6)$$

On substituting from Eq (6) for $P_{AB}(r)$ and performing the indicated summation, Eq (4) reduces to

$$P_{AB} = \frac{2}{3} \left(1 - e^{-\frac{3}{2}m} \right). \quad (7)$$

It should be noted that the M II frequency mapping function provided by Eq (7) behaves very much like its recombinant analog of Eq (4). For small values of m , P_{AB} is equal to m , just as for small values of m' , p_{AB} equals m' .

The derivation of relations (3), (5), and (7) assumes the absence of both chiasmata and chromatid interference. Under these conditions the average number of chiasmata per four strands is equal to twice the average number of chiasmata per two strands. Thus $2m'$ of Eq (4) is equal to m of Eq (7). These equations may therefore be solved for m , and, from the resulting equality, the desired relation between p_{AB} and P_{AB} is obtained:

$$p_{AB} = \frac{1}{2} \left[1 - \left(1 - \frac{3}{2} P_{AB} \right)^{2/3} \right]. \quad (8)$$

Eq (8) can be used to convert M II frequencies between the limits of 0 and $\frac{2}{3}$ into the corresponding recombinant map values. For small values of P_{AB} , the quantity $\left(1 - \frac{3}{2} P_{AB} \right)^{2/3}$ is approximated by $(1 - P_{AB})$. Under these conditions relation (8) reduces to the generally used approximation described by Eq (3). The range of P_{AB} values over which this approximation is useful may be seen from Table 1, in which are tabu-

lated corresponding p_{AB} values calculated with the aid of Eq (6). The difference in map units between the calculated values and those obtained from the approximation is indicated in the last column. For values of P_{AB} in excess of 0.2 the approximation becomes progressively more inaccurate. Because of the nature of the function, the extent of the divergence increases rapidly as P_{AB} approaches 0.67.

There are a number of instances in the literature of tetrad analysis in which discrepancies exist between map distances calculated from M II frequencies and those determined by recombinant proportions on identical segregating tetrads. Such discordances may arise from one or both of the following sources: (a) the application of the $\frac{1}{2}$ approximation in the conversion of M II frequencies to recombinant distances in situations where this yields an inaccurate estimation; (b) a departure from randomness in chromatid crossing over.

The use of Eq (8) would be expected to remove the discrepancy in those falling into the first category. It might, however, increase the degree of divergences that are due to aberrancies in chromosomal mechanics. It is of course the latter that are of greatest interest, and tetrad analysis derives its primary importance principally because it can detect such abnormalities from a comparison of M II and recombinant frequencies on the same material.

As an instance of the first type we may take an example from Whitehouse's (1) calculations of map distances in *Neurospora*. The locus for fluffy yielded 57.5% M II segregations and, using the approximation, was placed 28.8 map units away from its centromere. This represents relatively poor agreement with the map distance which is obtained from recombinant frequencies with two other loci, peach and tuft, lying between fluffy and the centromere. Correcting for double crossovers in the region between peach and fluffy, the recombinant values would place fluffy at 37.1 units from the centromere. The discrepancy is virtually removed, however, by using Eq (8) for the conversion, since it is found that an M II frequency of 57.5% corresponds to a recombinant map distance of 37.0.

Of greater interest is the existence of cases in which the correction fails to eliminate the discrepancy completely. Zickler (11), working with *Bombardia lunata*, reported a recombinant frequency of 37.1% between the loci for sex and color, whereas the corresponding M II frequencies were 62.7% and 57.7%, respectively. Zickler was of the opinion that these results were inconsistent with normal meiosis, since the M II frequencies yielded 60.2 or 2.5 as the alternative map distances between the two loci, and neither agreed with the recombinant value of 37.1. Ludwig (12) and Ryan (13) pointed out, however, that if one corrects for double crossovers between the two, assuming the loci are on opposite sides of the centromere, a recombinant value of 42% is obtained from the M II frequencies. This reduces the discrepancy to 5 map units. Both

TABLE 1
COMPARISON OF THE $P/2$ APPROXIMATION FOR RECOMBINANT MAP DISTANCES WITH THOSE OBTAINED FROM EQUATION (6)

| P | $P/2$ | p | Difference in map units |
|------|-------|-------|-------------------------|
| 0 | 0 | 0 | 0 |
| 0.10 | 0.050 | 0.056 | 0.6 |
| .20 | .100 | .106 | 0.6 |
| .30 | .150 | .165 | 1.5 |
| .40 | .200 | .228 | 2.8 |
| .50 | .250 | .302 | 5.2 |
| .60 | .300 | .392 | 9.2 |
| 0.67 | 0.335 | 0.501 | 16.6 |

authors, however, used the approximation in converting the M II frequencies. Employing the more precise relation increases the discrepancy to 11 map units. It would appear, then, that Zickler's data probably do require explanation, although it is clearly not necessary, as Ryan (13) pointed out, to accept his hypothesis of M II segregation of the centromeres.

References

1. WHITEHOUSE, H. L. K. *New Phytologist*, **41**, 23 (1942).
2. MATHER, K., and BEALE, G. K. *J. Genetics*, **43**, 1 (1942).
3. LINDEGREN, C. C. *Hereditas*, Suppl. Vol., 338 (1949).
4. PERKINS, D. D. *Genetics*, **34**, 607 (1949).

5. WHITEHOUSE, H. L. K. *New Phytologist*, **48**, 212 (1949).
6. ———, *Nature*, **165**, 893 (1950).
7. RIZET, G., and ENGELMANN, C. *Rev. cytol. biol. vegetales*, **11**, 201 (1949).
8. PAPAZIAN, H. G. *Genetics*, **36**, 441 (1951).
9. HALDANE, J. B. S. *Cytologia*, **3**, 54 (1931).
10. MATHER, K. *J. Genetics*, **30**, 53 (1935).
11. ZICKLER, H. *Planta*, **25**, 573 (1934).
12. LUDWIG, W. Z. *ind. Abs. Vererbungsw.*, **73**, 332 (1937).
13. RYAN, F. J. *Bull. Torrey Bot. Club*, **70**, 605 (1943).

Manuscript received April 28, 1952.¹

¹ After the present manuscript was accepted for publication a paper by Papazian (*Genetics*, **37**, 173 [1952]) appeared in which relation (8) was derived by a somewhat different argument.

Comments and Communications

Scientific Personnel in the USSR

ANALYSIS of recent Soviet official reports¹ indicates a rapid rate of growth in that country's professional labor force, both in absolute numbers and in relation to total nonagricultural employment. In 1952 the number of persons employed in professional positions who were graduates of higher educational institutions in industry, agriculture, and health totaled 860,000 as compared with 358,000 in 1937. As a proportion of total employment excluding collective-farm workers, this figure increased from about 1.3% in the earlier year to 2.0% in the later.

The 1952 professional labor force includes about 475,000 engineers and natural scientists in manufacturing, construction, transportation, and communications, plus some 145,000 in agriculture. It comprises about 240,000 physicians, dentists, and pharmacists. Professors and instructors in higher educational institutions numbered 80,000 in 1950. In that year, teachers in primary and secondary schools totaled 1,600,000, but two thirds of them had only a secondary school education.

Whereas the over-all enrollment in Soviet primary and nonspecialized secondary schools (37 million in 1950) has been little greater than before the war, that in technical and other specialized secondary schools has risen rapidly. By 1948 it had reached 1,094,000 as compared with 823,000 in 1940; the numbers of graduates in the two years were 252,000 and 164,000, respectively. Comparable data are unavailable for 1952, although the rise in technical school enrollments and graduations has unquestionably continued.

In higher education, the trend has been comparable. By 1948 the number of full-time undergraduate and graduate students aggregated 734,000, compared with

583,000 in 1940. The 1952 figure approximated 974,000. Furthermore, the number of persons taking part-time or correspondence courses has jumped from 229,000 in 1940 to half a million in 1950. The number graduating was 102,000 in 1940, 122,000 in 1948, and about 127,000 in 1950. Graduate students working for strictly research degrees (*Kandidat* and *Doktor*) totaled 21,000 in 1950, compared to a 1941 goal of 13,300. On the other hand, the number of higher educational institutions has increased somewhat more slowly than enrollment: 782 in early 1941; 880 in 1950.

Data are unfortunately lacking for a current breakdown of enrollment and graduation in higher educa-

TABLE 1

| Speciality | Percentage of total | |
|--|---------------------|------------------|
| | Enrollment | Annual graduates |
| Industry | 24.4* | 20.9* |
| Transportation and Communications | 5.6* | 5.9* |
| Agriculture | 8.2* | 7.8* |
| Medicine | 18.6 | 16.3 |
| Education | 37.3 | 42.6 |
| Including foreign-language specialists | 2.9 | 2.5 |
| Art | 1.3 | 1.4 |
| Economics | 1.9 | 2.6 |
| Law | 1.1 | 1.0 |
| Others | 1.6 | 1.5 |
| Total | 100.0 | 100.0 |

* At least one fifth administrators and political officers.

tion by fields, but it is clear that major fluctuations have taken place in recent years. Thus the immense shortages of medical personnel caused by World War II led to a very high output (presumably based on an accelerated program) in 1948 and 1949. In those years the net increases in Soviet physicians, graduate dentists, and graduate pharmacists were 24,000 and 26,000, respectively. For 1950, however, the number

did not exceed 13,000—a figure substantially below the 1941 (peacetime) goal of 18,600.

With these cautions, the data from the 1941 plan are presented as rough approximations of the breakdown by *undergraduate* fields (Table 1).

In summary, substantial evidence is available from Soviet official sources to indicate a rapid rate of increase in that country's professional labor force in recent years. Furthermore, it is likely that the data presented are considerably under the actual totals, for I do not believe that military institutions, which play an important role in Soviet higher education and research, are included. As a whole, this qualitative improvement of the Soviet labor force opens up possibilities of profound new developments in science, technology, and other fields. It is a phenomenon that permits of no complacency on the part of the West.

DEMITRI SHIMKIN

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Perfection and Ideality

IN A paper now being published by the Willow Run Research Center,¹ we have included the following definitions in the glossary:

Perfect gas—one which conforms to the state equation $P = \rho RT$.

Ideal gas—a perfect gas which has constant specific heats.

In theory, assumptions that lead to perfection may also lead to ideality. In practice, however, these concepts are used for purposes of approximation, and derivations often make use of the one approximation without wishing to imply the other.

The advantage in scientific writing of having words with precise meanings is, of course, well known. The terms "perfect gas" and "ideal gas" have long been used interchangeably, with little regard for which of the above two definitions is meant. I should like to recommend consideration of the general adoption of these definitions.

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¹ UMM 97, a shock tube investigation of detonative combustion, by R. B. Morrison.

Age of the Denbigh Flint Complex¹

THE Denbigh flint complex (1), the oldest well-known cultural horizon in Alaska, has aroused widespread interest and speculation as to its antiquity (2, 3). This fact makes desirable a preliminary notice of results obtained in geologic investigations at Iyatayet, the discovery site. The geologic significance of several related sites in the Brooks Range also needs clarification.

¹ Publication authorized by the Director, U. S. Geological Survey.

Iyatayet, the site of excavations by J. L. Giddings, Jr., is located on the west coast of Cape Denbigh on Norton Bay, 115 miles east of Nome, Alaska. Evidence from topographic features, sediments, soils, and cultural deposits indicates that people of the Denbigh flint complex occupied Iyatayet Valley during a warm interval preceded and followed by intervals when the climate was colder than at present. The warm interval during which the site was first occupied probably coincided with a warm interval about 8500 years ago, recorded by dated muck north of Nome; but it may have coincided instead with an older, pre-Mankato warm interval more than 10,000 years ago, represented by dated muck near Fairbanks.

Cultural objects belonging to the Denbigh flint complex have been collected on glacial deposits at three sites in the Brooks Range in northern Alaska (4, 5). According to Solecki (5), "the fact that these early manifestations were found in glaciated areas conclusively points out that these sites were occupied during post-glacial times." However, several distinct ice advances, each less extensive than its predecessor, are recognized in the Brooks Range (6). None can be dated at present. The glacial sediments upon which objects of the Denbigh flint complex were found may have been deposited during a relatively early advance, and examination of air photos suggests that this is the case in at least one of the sites. On the basis of present knowledge, therefore, it can only be said that the Brooks Range sites are younger than an early glacial advance; they are not necessarily younger than the latest Pleistocene glacial advance.

Giddings and I have in preparation a manuscript describing in detail the results of geologic investigations at Iyatayet.

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U. S. Geological Survey
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References

1. GIDDINGS, J. L., JR. *Am. Antiquity*, **16**, 193 (1951).
2. COLLINS, H. B. *Smithsonian Publ. No.* 4041, 460 (1950).
3. SOLECKI, R. S. *Sci. American*, **104**, 14 (1951).
4. IRVING, W. *Am. Antiquity*, **17**, 52 (1951).
5. SOLECKI, R. S. *Ibid.*, 55.
6. DETTERMAN, R. F. Personal communication.

Common Names for Subspecies

AS AN amateur ornithologist, albeit professionally a taxonomic botanist, I must endorse wholeheartedly the plea voiced by Howard Campbell in *SCIENCE* for June 6.

There has recently been an epidemic of subspecific common names in ornithology, along with many proposed changes of specific common names, some of which—e.g., gray jay for Canada jay (*Perisoreus canadensis*)—seem to serve no useful purpose. Some lists of proposed names have been published and have been followed in varying degrees by many bird clubs, sometimes with an astonishing degree of confusion. For three years I undertook to prepare Christmas bird census lists for publication in the *Canadian Field-*

Naturalist and occasionally found a club reporting a bird under two names. Finally the job became so complex that I had to turn it over to a professional zoologist with adequate library facilities.

Perhaps the most unfortunate aspect of this name fad is that it encourages the already common tendency among bird watchers to put a trinomial on everything that they see, a practice that has been heartily condemned by leading field ornithologists. Thus every robin seen in this area is called an Eastern robin

(*Turdus m. migratorius*), although it is increasingly evident that appreciable numbers of the black-backed robin (*T. m. migriderus*), breeding in Ungava, pass through here in spring and fall.

In any event, as more subspecies are recognized, many subspecific common names become almost meaningless. Witness the splitting in recent years of the "common" Canada goose.

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Scientific Book Register

Comets and Meteor Streams. International Astrophysics Series, Vol. 2. J. G. Porter. New York: Wiley, 1952. 123 pp. Illus. \$5.25.

Shock and Circulatory Homeostasis. Transactions of the First Conference, October 22-3, 1951, New York. Harold D. Green, Ed. New York: Josiah Macy, Jr. Fdn., 1952. 245 pp. Illus. \$3.50.

Parental Care and Its Evolution in Birds. Illinois Biological Monographs, Vol. XXII, Nos. 1-3. S. Charles Ken-deigh. Urbana: Univ. Illinois Press, 1952. 356 pp. Illus. \$5.00; \$4.00 paper.

Atomic Energy Levels as Derived from the Analyses of Optical Spectra. Vol. II, 24Cr-41Nb, Cir. 467 of the National Bureau of Standards, 1952. Charlotte E. Moore. Washington, D. C.: Supt. Documents, GPO. 227 pp. \$2.25.

The White Plague: Tuberculosis, Man and Society. René and Jean Dubos. Boston: Little, Brown, 1952. 277 pp. \$4.00.

Psychology in the World Emergency. John C. Flanagan et al. Pittsburgh: Univ. Pittsburgh Press, 1952. 198 pp. \$4.00.

Theory of Elasticity and Plasticity. Harvard Monographs in Applied Science, No. 3. H. M. Westergaard. Cambridge, Mass.: Harvard Univ. Press; New York: Wiley, 1952. 176 pp. Illus. \$5.00.

Plant Physiology. 2nd ed. Bernard S. Meyer and Donald B. Anderson. New York-London: Van Nostrand, 1952. 784 pp. Illus. \$8.50.

Foundations of Algebraic Topology. Samuel Eilenberg and Norman Steenrod. Princeton, N. J.: Princeton Univ. Press, 1952. 328 pp. \$7.50.

Beef Cattle. 4th ed. Roscoe R. Snapp; with a chapter on "Sterility" by Harry Hardenbrook, Jr. New York: Wiley; London: Chapman & Hall, 1952. 641 pp. \$6.50.

Vector Analysis. Earl C. Rex. Dubuque, Iowa: Brown, 1952. 88 pp. Illus. \$3.25.

Chemistry of Carbon Compounds: Aliphatic Compounds. Vol. I, Pt. B. E. H. Rodd, Ed. Amsterdam-Houston: Elsevier, 1952. 684 pp.

Methods in Medical Research. Vol. 5. A. C. Coreoran, Ed. Chicago: Year Book Pub., 1952. 394 pp. Illus. \$7.50.

Antibiotics: A Survey of Their Properties and Uses. Published by direction of the Council of The Pharmaceutical Society of Great Britain. 2nd ed. London: Pharmaceutical Press, 1952. 290 pp. Illus. 25s.

The Case of Dora and Other Papers. Sigmund Freud; trans. by Joan Riviere et al. New York: Norton, 1952. 243 pp. \$3.50.

Roger Bacon and His Search for a Universal Science. A reconsideration of the life and work of Roger Bacon in the light of his own stated purposes. Stewart C. Easton. New York: Columbia Univ. Press, 1952. 255 pp. \$4.00.

Advances in Protein Chemistry. Vol. VII. M. L. Anson, Kenneth Bailey, and John T. Edsall, Eds. New York: Academic Press, 1952. 411 pp. \$8.50.

Mechanics and Properties of Matter. Reginald J. Stephenson. New York: Wiley; London: Chapman & Hall, 1952. 371 pp. \$6.00.

Biochemical Studies of Bacterial Viruses. E. A. Evans, Jr. Chicago: Univ. Chicago Press, 1952. 68 pp. \$2.75.

Little Ship Astro-Navigation. M. J. Rantzen. New York: Philosophical Library, 1952. 160 pp. Illus. \$4.75.

Highway Curves: Highway Surveying, Location, Geometric Design, and Earthwork (Ives). 4th ed. Philip Kissam. New York: Wiley; London: Chapman & Hall, 1952. 389 pp. Illus. \$7.00.

The Pharmaceutical Curriculum. A report prepared for the Committee on Curriculum, American Association of Colleges of Pharmacy. Lloyd E. Blaueh and George L. Webster. Washington, D. C.: American Council on Education, 1952. 257 pp. \$2.00.

Business Be Damned. Elijah Jordan. New York: Schuman, 1952. 267 pp. \$4.00.

Quantitative Chemical Analysis. 10th ed. Leicester F. Hamilton and Stephen G. Simpson. New York: Macmillan, 1952. 529 pp. Illus. \$4.50.

An Autobiographical Study. Sigmund Freud; trans. by James Strachey. New York: Norton, 1952. 141 pp. \$2.50.

Mental Prodigies. An enquiry into the faculties of arithmetical, chess and musical prodigies, famous memorizers, precocious children and the like. Fred Barlow. New York: Philosophical Library, 1952. 256 pp. \$4.75.

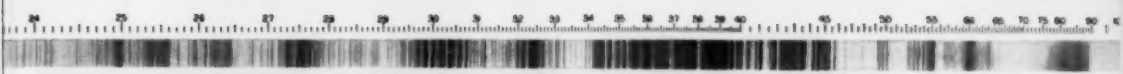
Lecture Demonstration Experiments for High School Chemistry. Fred T. Weisbrueh. St. Louis, Mo.: Educational Pub., 1952. 333 pp. Illus. \$4.50.

Semimicro Laboratory Exercises in General Chemistry. 2nd ed. J. Austin Burrows, Paul Arthur, and Otto M. Smith. New York: Macmillan, 1952. 302 pp. Illus. \$3.50.

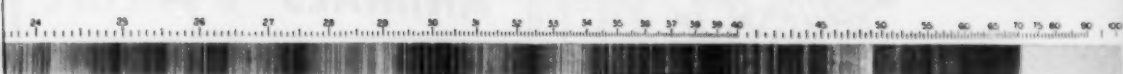
The Science of Zoology. James C. Perry. Milwaukee: Bruce Pub., 1952. 709 pp. Illus. \$6.50.

History of American Psychology. A. A. Roback. New York: Library Pub., 1952. 426 pp. \$6.00.

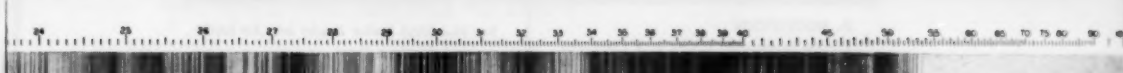
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Publications Received

- Alcohol Education: A Guide-Book for Teachers.* Joseph Hirsh. New York: Schuman, 1952. 107 pp. \$2.50.
- Annual Report of the Librarian of Congress for the Fiscal Year Ending June 30, 1951.* Washington, D. C.: The Library of Congress, 1952. (Order from Supt. of Documents, GPO.) 180 pp. Illus. \$1.75.
- Contemporary Ethiopia.* David Abner Talbot. New York: Philosophical Library, 1952. 267 pp. \$4.50.
- Galileo: First Observer of Marvelous Things.* Elma Ehrlich Levinger. New York: Messner, 1952. 180 pp. \$2.75.
- The Hall of Light: A Study of Early Chinese Kingship.* William Edward Soothill; Lady Hosie and G. F. Hudson, Eds. New York: Philosophical Library, 1952. 289 pp. Illus. \$7.50.
- Laboratory Experiments in College Chemistry.* V. R. Damerell. New York: Macmillan, 1952. 124 pp. Illus. \$1.75.
- Laboratory Manual for Introductory Chemistry.* Lillian Hoagland Meyer. New York: Macmillan, 1952. 114 pp. Illus. \$1.75.
- Liberal Arts Dictionary in English, French, German, Spanish.* Mario A. Pei and Frank Gaynor. New York: Philosophical Library, 1952. 307 pp. \$6.00.
- The Life Science: Powers of the Mind,* Vol. II. Paul Maslow. 16 Court St., Brooklyn, N. Y.: The author, 1952. 288 pp. \$3.50.
- Lipid Metabolism.* Biochemical Society Symposium No. 9. R. T. Williams. New York: Cambridge Univ. Press, 1952. 102 pp. \$2.75.
- Logic and Scientific Method.* Gregory D. Walcott. New York: Barnes & Noble, 1952. xii + 183 pp. \$2.75.
- Modern Trends in Infant Nutrition and Feeding.* Sci. Rept. Ser. No. 14. Jonathan T. Lauman. New York: Sugar Research Foundation, 1952. 96 pp. Free.
- National Bureau of Standards. Annual Report 1951.* Misc. Pub. 204. Washington, D. C.: GPO, 1952. 105 pp. Illus. 50¢.
- New and Unusual Species of Brachiopods from the Arbuckle Group in Oklahoma.* Vol. 117, No. 14. Pub. 4093. G. Arthur Cooper. 35 pp.; 4 plates. *The Foraminiferal Genus Triplasia Reuss, 1854.* Vol. 117, No. 15. Pub. 4094. Alfred R. Loeblich, Jr., and Helen Tappan. 61 pp.; 8 plates. Charles D. and Mary Vaux Walcott Research Fund. Washington, D. C.: Smithsonian Inst., 1952.
- Neutron Cross Sections.* A Compilation of the AEC Neutron Cross Section Advisory Group, D. J. Hughes, Chairman. Washington, D. C.: Off. Tech. Services, Dept. of Commerce, 1952. 93 pp. \$1.00.
- Proteins and Enzymes.* Lane Medical Lectures. Stanford Univ. Pub., Univ. Ser., Med. Sciences, Vol. VI. Kaj Ulrik Linderström-Lang. Stanford, Calif.: Stanford Univ. Press, 1952. vi + 115 pp. Illus. \$3.00.
- Report of the University Museums, 1950-1951.* Repr. from President's Report for 1950-51. Ann Arbor: Univ. Michigan, 1952. 30 pp.
- Research and Development Associates Food and Container Institute, Inc. Proc. 1952 Meeting, Apr. 15-16, Chicago.* Chicago: Research and Development Associates Food and Container Inst., 1952. 136 pp.
- Road Test One-MD.* Highway Research Board Special Report 4. Pub. 227. Washington, D. C.: National Academy of Sciences—National Research Council, 1952. vii + 142 pp. + appendix. Illus. \$2.25.

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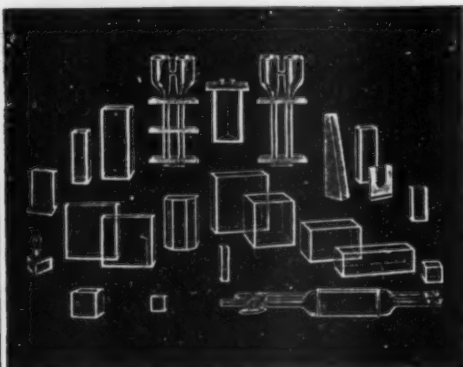
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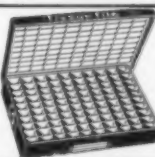
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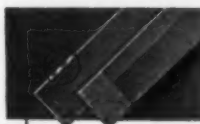
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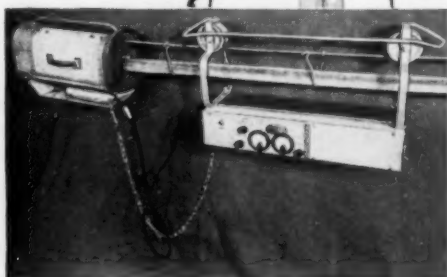
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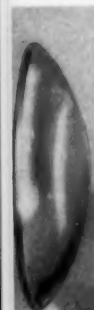
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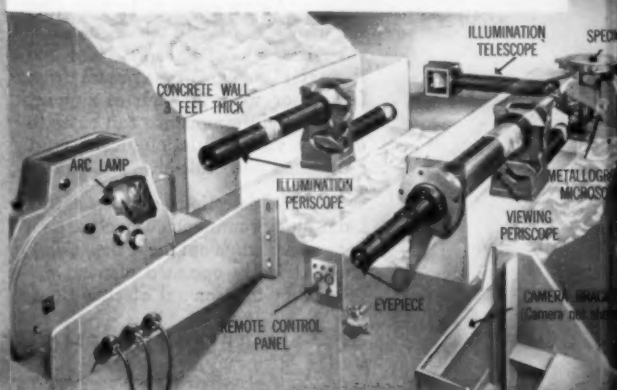


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